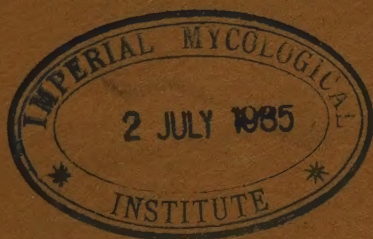


FORTY-SIXTH ANNUAL REPORT
OF THE
Agricultural
Experiment Station
OF THE
UNIVERSITY OF KENTUCKY

LEXINGTON, KENTUCKY



PART II

Bulletins 337-345

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FORTY-SIXTH ANNUAL REPORT
of the
Agricultural Experiment Station
of the
UNIVERSITY OF KENTUCKY
For the Year 1933



Part I
Report of the Director

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LEXINGTON, KENTUCKY

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LETTER OF TRANSMITTAL

To His Excellency, Hon. Ruby Laffoon, Governor of Kentucky.

Sir: In accordance with an act of Congress, approved March 2, 1887, entitled, "An Act to establish Agricultural Experiment Stations, in connection with the Agricultural Colleges established in the several states under the provisions of an act approved July 2, 1862, and under the acts supplementary thereto," and of the act of the Legislature of the State of Kentucky, approved February 20, 1888, entitled, "An Act to accept the provisions of an act passed by the Congress of the United States, approved March 2, 1887, for the establishment and maintenance of Agricultural Experiment Stations in connection with Agricultural Colleges established by the several states and territories under an act of Congress approved July 2, 1862," I herewith submit the Forty-Sixth Annual Report of the Kentucky Agricultural Experiment Station.

Very respectfully,

THOMAS P. COOPER, *Director.*

January 1, 1934.

ANNUAL REPORT

of the

DIRECTOR OF THE KENTUCKY
AGRICULTURAL EXPERIMENT STATION

For the Year 1933

The rapid succession of economic events of the past year, as related to agriculture and rural welfare, has placed an increased responsibility upon the personnel of the Kentucky Experiment Station. Many research projects have been curtailed or deferred, and projects generally have been modified to meet the current developments. Necessarily, the personnel has been diverted from its customary assignments to meet the emergencies by contributions to, and conferences upon, the various national programs as they affect the agriculture of the state. It has been the policy, as far as possible, to provide technical advice and instruction on the agricultural programs thru the staff of the research departments.

It is significant that, irrespective of the changes in the economic situation, the farmers have continued to find the Experiment Station that constant source of information, based upon research and study, which they require in the conduct of their affairs. The staff has devoted much time to conferences with individuals who were in need of specific information resulting from various researches as it applied to their problems.

Correspondence, requests for bulletins and the many types of technical services reached a high point in 1933. As pointed out in a previous report, periods of depression, of difficulty and of economic and social changes, enlarge the farmers' demands for information from their research institutions. Thus,

the Experiment Station, thru its technical staff, has an increasingly important part in individual as well as national action for economic recovery.

Members of the research staff in economics have been loaned, for limited periods of time, to the Agricultural Adjustment Administration, as technical advisers to aid in the development or application of certain features of the national program. The results of research of past years have often made possible a direct contribution to plans for the betterment of the economic situation.

National legislation has given opportunity for the utilization of results from several of the important research projects of the Experiment Station. Studies on tobacco marketing, farm organizations, the social and economic study of the Appalachian highlands, land use, farm tax studies, sources of farm income as well as many other projects, have furnished valuable and up-to-date material on current problems.

The research of departments less affected by the abnormal activities of the year has progressed satisfactorily. As shown in the following pages, progress has been made in many important fields of work. Research in biological and chemical problems has developed new facts adaptable to the varied livestock and plant problems of the state.

The experiment substation in Western Kentucky and the Robinson Substation in Eastern Kentucky have continued the work of service to their respective regions. Reductions in appropriations for their support have necessitated the elimination of some of the less important work, the curtailment of certain major activities and the limited furloughing, without pay, of employees. These substations are proving of increased value to the state and particularly to the regions in which they are located. That the substations are serving their purpose well is shown by improved farm practices in their respective regions.

A Civilian Conservation Corps Camp was established, early in the year, by the State Forester and the United States Government on the Robinson forest, a part of the property of the Robinson Substation. The forester of the substation was loaned

to the Government to aid in the direction of the camp's activities and other employees have been transferred as foremen and laborers. This camp has been of great assistance to the substation. Its operations have conserved the funds of the substation thru improvements in the property which it has initiated and by taking over the customary work of fire protection. Much work, involving the making of trails, clearing of undergrowth and the utilization of the chestnut destroyed by blight has been undertaken and completed. Various parts of the property have been made more accessible, fire hazards have been reduced and the outlook is promising for the future productivity of the forest. The construction of a roadway from the main highway to headquarters, a distance of over four miles, has been one of the substantial accomplishments. The roadway is well graded, drained and graveled, and has adequate bridges and culverts. It makes possible direct automobile and truck transportation between Quicksand and the camp headquarters. Where formerly a day was required to make the journey from Quicksand to the forest property, it can now be made by truck or automobile in forty-five minutes. Aside from the convenience of administration and the opening of this property to public inspection, the roadway has an important economic value in making possible the movement of the products of the forest to markets.

The commercial feed and fertilizer control, the public service laboratories, the seed laboratory and the creamery license section have been called upon for greater services during the year. In many instances, demands are overtaking the staff and laboratory facilities available. These services are of direct assistance and protection to the farmer, to many industries and to a large group of citizens who may be indirectly interested in agriculture. The support and development of these services are essential to the well-being of agriculture.

The Experiment Station views the new problems of the state, whether economic, social, biological or chemical, as offering additional opportunity for effective service. Research and service functions may be developed only to the extent that appropriations are made available by the state or nation. In-

creased income to the Experiment Station will be reflected in increased results that may be utilized by the forward-looking farmer. The support of the Experiment Station is an investment which earns for the citizens of the state very large annual returns.

The meteorological summaries, compiled from the records of the United States Weather Bureau Station at Lexington, which have been presented in the annual report of the Experiment Station continuously since 1894, are omitted this year because of the discontinuance of the Lexington station July 1, 1933.

The varied activities of the Experiment Station for the year are presented briefly in this report. Results of work and detailed reports of research projects are issued from time to time in bulletins and circulars which are available upon request.

Taxation of Farm Real Estate. A primary consideration in making this study was to determine the tax-paying ability of the several counties. In determining this ability, both the absolute amount and the form of the taxable wealth were considered. This analysis revealed great differences among the counties in both particulars. For instance, the ten wealthiest counties contained 45 per cent of all property in the State subject to county taxes. Again, the tax base of the wealthiest county, Jefferson, was 400 times that of the poorest county, Elliott.

The differences in the types of taxable property were fully as great and probably as significant as the differences in the amounts of such property. The taxing status of counties with high percentages of farm land values is entirely different from that of those with high percentages of corporate property. The fluctuations of farm income are great, also, as is only too apparent during the present depression, while the income from property of public carriers and utilities, which make up the bulk of corporate property for county taxation, is more stable.

In 1932, tax revenues were highest in Jefferson county (\$1,913,050) and lowest in Elliott (\$16,729). The seriousness of inadequate local tax revenues in Kentucky can be appreciated by the fact that in 1932 taxes for general county purposes

amounted to less than \$25,000 in seven counties, less than \$50,000 in 36 others, and more than \$100,000 in only 28 counties. Thus, in more than one-third of the counties of Kentucky, high rates of taxes are necessary if only nominal governmental services are provided. The significance of this general condition in relation to the support of local governmental service can readily be appreciated.

Further analysis of data gathered for an index of farm taxes in Kentucky showed that counties differed greatly both in the amounts of farm real estate tax increases and in the years when the peaks of these increases occurred. For instance, farm real estate taxes increased 115.5 percent in Rowan County, from 1913, and 329.9 percent in Webster County. Again, the peak of farm real estate taxes was reached in 1920 in Adair County and in 1931 in Shelby County. Generally speaking, farm real estate taxes had declined most by 1931 in those counties where the greatest increases had occurred. Conversely, the smallest declines had occurred in those counties where farm real estate taxes had increased the least. Upon the basis of taxable wealth, increases in such taxes were smaller in the wealthier than in the poorer counties. Also, tax declines by 1931 were less in the poorer than in the wealthier counties. This situation suggests the hard straits, under the present arrangement of county support for many governmental services, to which poorer counties are driven in maintaining schools, roads and other services.

Another interesting fact, was the doubling, from 1924 to 1932, of the share of the cash income of Kentucky farmers required for taxes. By years, the percents of the cash income of Kentucky farmers required for taxes were as follows:

Year	Percent
1924	6.9
1925	7.0
1926	8.0
1927	8.0
1928	6.8
1929	7.3
1930	9.9
1931	11.5
1932	12.9

These increases in the share of the cash income required for taxes were chiefly the result of a decline in the prices of farm products, which amounted to about 65 percent.

Farm Taxes and County Government in Kentucky. The field work, for this study, was done in Livingston and Crittenden counties, which are rural, with relatively little taxable property. The difficulty of making recommendations for improving local government in view of the limited local tax revenues was an outstanding feature of the study. A major conclusion of the study is to the effect that to maintain acceptable services in these two counties, according to common standards of local government, either the state will have to provide more aid for selected services, perhaps schools and roads, or certain major types of property now taxed only by the state will have to be remanded to the counties for tax purposes.

Another striking feature revealed by this study was the restriction by state statute of freedom of action in local governmental affairs. Enacted in the spirit of regularizing county government and protecting the citizens against possible excesses and inefficiency, the laws of the state, in many instances, act in these times of emergency as fetters to prevent counties from taking action in dealing with relief, roads, elections and the like, that is now badly needed to develop more efficient government. More definite conclusions must await the completion of this study.

Utilization and Classification of Land. The field work of the study was carried on in the mountain area of Eastern Kentucky. The 34 counties which comprise this region have a total area of 12,000 square miles and a population of 764,000 or nearly one-third of the total area and population of the state. The greater part of the area is unsuitable for agriculture, yet more than three-fourths of the people live in the country.

The marked disparity between this and the better agricultural sections of Kentucky in the resources which condition standards of living is exemplified by contrasting County L in the area with County B in Central Kentucky. The amount of land in farms in the two counties is practically the same. Much

of the tillable land in county L is submarginal. Practically all the land in county B is highly productive. In county L, the farm population is nearly twice that of county B; county L has less than one-third as many acres of tillable land per person as county B. There are nearly twice as many children of school age in county L as in county B, but the property subject to assessment for school purposes in county L is only one-tenth that of county B.

For more than a generation the people of this region have derived a great part of their incomes from non-farming sources such as lumbering and mining. Thus in 1929, out of a group of 228 typical farm families, only 15 percent derived their living mainly from farming. Since 1929, the opportunities for gaining an income from non-farming sources have largely disappeared. This lack of outside sources of income, coupled with the small amount of good agricultural land per family, resulted in widespread poverty. During a considerable part of 1933, more than half of all families in the 34 mountain counties were accepting some type of relief. A factor which added materially to the difficulty of the situation was that many families which had previously gone out from the region to engage in mining and other industrial occupations were forced by the shutting down of these industries to return to the communities from which they had emigrated. This added a further burden to the already limited food-producing area and housing facilities. A total of 7,600 families returned to 22 Eastern Kentucky counties during the two years prior to March 1, 1932, increasing by one-sixth the families in the area.

An intensive study of the land and the people residing on it was made in two typical contiguous magisterial districts in Knox County. The entire area, consisting of 67,760 acres, making up the drainage basin of Stinking Creek, one of the important tributaries of the Cumberland River, was mapped. Two areas of steep land, now exclusively woodland and brush land, were designated as Class I. The land located principally in the drainage basin of the three forks of Stinking Creek and the upland area of the main trunk of Stinking Creek were designated

as Class II. The land along lower Stinking Creek and the Cumberland River, consisting of a considerable proportion of good crop land, was designated as Class III. Of the total areas of the two magisterial districts, woodland and brush land occupied two-thirds, pasture about one-fifth, and crops about one-eighth. Four-fifths of the crop land was in corn.

The sales from crop and livestock enterprises averaged \$48 per family, which was barely sufficient to pay current farm expenses. Without the income from outside sources, these families would have had nothing with which to purchase clothing, food and other consumption goods and services. Outside income averaged \$53 per family, \$15 of which came from work relief and direct relief. Labor and other services of various kinds performed away from the farm made up most of the other part of the \$53. The net income for the year available for living expenses averaged less than \$50 per family of $5\frac{1}{2}$ persons.

The level land suitable for crop production averaged but little more than 9 acres for each of the 176 families. Families on the upper reaches of Stinking Creek and its branches had level land averaging but $2\frac{1}{2}$ acres each, and net cash income averaging less than \$40. Seventy-two of the 176 families had less than \$25 each for living expenses for the year.

On the level land, a day's work produced an average of 3.3 bushels of corn. On land having a slope greater than 10 degrees (two-thirds of all the corn produced in this area was grown on land ranging in slope from 11 to 40 degrees) the production of corn averaged but 1.2 bushels for a day's work. In contrast, corn grown in Christian County, on large, level fields and with modern tillage implements, gave a production of 15 bushels per day of man labor spent on the crop.

A serious handicap is that much of the level land in the valleys is poorly drained and too wet for tilled crops. It has been demonstrated that drainage can be accomplished readily thru (1) cleaning out and, to some extent, enlarging and straightening the channels of creeks and branches, to take care of surface run-off water and to lower the water table of the bottom lands; (2) opening ditches to carry off surface water not caught

by the stream beds so treated; (3) using a limited amount of underground drainage or tiling to handle seepage water.

The data gathered in the various phases of the study point to some measures for rehabilitation, which are here presented as a tentative program for the area:

Areas of land, such as that designated as Class I, might well be reserved at once as permanent forest land. Farming on land in Class II, consisting of the rough land in the upper reaches of the forks of the creeks, should eventually be abandoned, and the land reserved for permanent forest use. Land in Class III, consisting of areas with a considerable proportion of good, level, arable land, should be used permanently for agricultural production. The use of the more intensive kinds of crops and the intensity of culture of all crops on this land should be increased.

Families on the rougher, poorer land, most of whom now depend upon public relief, should have opportunity to develop as completely as possible land resources which will enable them to live where they now are. This may necessitate the giving of more or less relief to many of these families for a considerable period in the future. This, however, will be less costly than to remove these families and it will avoid the difficulties of social adjustment which removal would entail. Eventually, a large proportion of these families may desire to remove to areas offering better opportunities for making a living. The best policy requires that this be done slowly and voluntarily. A period of a generation or more may be required. Industries should be encouraged to locate at various points in the areas. Families that can get industrial employment should be encouraged to do so. All families should be encouraged to produce food for subsistence. However, there will still be the problem of obtaining cash for the purchase of non-food necessities. Many who do not have surplus products for sale will have to rely on employment for wages to provide cash. A limited number of the ablest and most intelligent families on farms of unfavorable opportunities, will decide that they can improve their conditions by leaving their holdings and moving to better land. Such families

should be given guidance and assistance. When possible, the relocation should be near the home locality but, in some cases, it may serve the interests of the families if the removal is to better land farther away. To test the possibilities of such migration it may be advisable for a government agency to encourage and aid some type or types of non-profit organization which would acquire tracts of land to be subdivided, improved and sold to competent families on a long-time plan of repayment and low interest rates.

Programs for restoring farm families to a self-sufficient base, in areas similar to those described, should begin by making more useful the limited amount of potential tillable land. The attention given to intensive crops such as potatoes and truck crops should be increased and more intensive methods should be employed in the production of all crops grown for the purpose of producing a maximum food supply. Wet and poorly drained land should be brought to a state of maximum productivity by clearing out stream beds thereby lowering the water table, and by ditching and draining. Some of the sloping land should be terraced. On farms where there is no level land the special preparation of home garden plats of limited area by the construction of retaining walls would enable families to improve the quantity and quality of their food supplies. The steeper land should be used for growing trees and the land of more moderate slope, especially at the lower zones of the hillsides, should be seeded to meadows and pastures.

Farm Business Studies. These studies included the analysis of 770 entire businesses and of 439 individual enterprises from the most important agricultural areas. The chief objective of the business analyses was to develop conclusions as to the combination and proportion of the enterprises that would result in the most economical farm organization and management and the largest net profit to farm operators in each agricultural area. The analysis of individual enterprises showed the cost of production and the gross and net returns from these enterprises and the factors which are most influential in decreasing unit costs of production and in increasing net returns of the

enterprises. Such analysis also provides a basis of comparison of the various crops and livestock as to the net returns which these enterprises contribute to the net returns from the farm as a whole.

The operators of the 10 most profitable farms, out of a group of 59 farms in Central Kentucky, had net earnings averaging \$1,006 above 5 percent interest on the invested capital. In addition, they provided \$768 worth of products for family living, thus earning for their operators \$1,774 for labor and management or the equivalent of about \$150 per month. As compared to this, the average farm studied returned \$34 per month in operator's net earnings. This wide difference in returns was the result of larger receipts from tobacco from a larger acreage, better yields, and a superior quality. More than 57 percent of all income was from the tobacco crop.

The most successful small farms had five times as many dairy cows as beef cows, while the most successful large farms had 3 beef cows for each dairy cow. On the small farms only about 30 percent of the tobacco was raised by tenants, while 70 percent of it was tenant-produced on the large farms. The farmers of the most profitable group had a greater proportion of their land in tobacco and a smaller percentage of their tobacco was raised by tenants.

Prices of Kentucky Farm Products in Recent Years. This project has for its purpose the establishment of an index of the price of farm products in Kentucky. The work of gathering price and sales data had been completed prior to the year under review. In order to determine the most desirable form of index several indexes were calculated, all of which were founded on one of four possible combinations of base data. The base quantity of products sold was that of the five-year period, 1926-1930.

The problem of seasonal variations in both marketings and prices discussed in the last report has been considered further. A monthly index based on average prices during the sixty months from January, 1925, to December, 1929, was prepared, and another based on average prices in the five corresponding months during this period. The object of this procedure was to

have one index with no adjustment for seasonal variation and another in which such an adjustment had been made. A similar pair of indexes were calculated by using the five years, 1910-1914, prior to the World War as a price base.

An examination of these indexes indicates that the first does not give a true picture of changes in Kentucky farm prices from month to month because of the influence of such products as tobacco, lambs and strawberries which are sold during only part of the year. On the other hand, the second index shows violent fluctuations from month to month, in some instances, due not to any actual change in prices but to a change in the commodities included in the index. Tobacco appears to be the chief cause of such fluctuations because the prices of tobacco have not changed uniformly with prices of other farm products. It seemed desirable, therefore, to break down the index into component parts. Six different indexes were calculated, each on both the 1910-14 base and the 1925-29 base.

The indexes which were calculated are:

1. An index of the prices of all farm products in Kentucky.
2. An index of prices of livestock and livestock products.
3. An index of prices of all crops.
4. An index of prices of six types of tobacco.
5. An index of prices of all farm products other than tobacco.
6. An index of prices of all crops other than tobacco.

With the use of certain tentative data, these indexes were calculated for each month for the years 1910 to 1932, inclusive. The problem of revising a part of the data and that of determining which index or the combination of which indexes is to be used for publication and future analysis remains to be done.

Seasonal Movement of Tobacco Prices. The seasonal movement of burley tobacco prices on the Lexington market was studied during the last marketing season. It is a well-known fact that average prices vary considerably thruout the season and it is popularly supposed that prices paid for tobacco of specific grades and quality vary likewise. There has been, there-

fore, a general striving, on the part of farmers, to market their tobacco during the "peak" of prices, with a consequent rush to market accompanied by congestion and a distinct shortening of the marketing season.

A study of weekly average market prices indicates that the usual seasonal movement is for prices to rise from the opening of the markets up to the 3rd, 4th, 5th, or 6th week, after which they fall rapidly until at the end of the season, prices average nearly 50 per cent below the average for the entire season. In recent years the highest weekly price has ranged from 10 to 20 percent above the average for the entire season. Altho there are exceptions, this movement of prices has been reasonably uniform from year to year.

If the prices of specific grades of tobacco are considered, however, the seasonal movement is much less pronounced. In any year, a particular grade may rise in price thruout the season, while in another it may remain constant or decline. There appears to be little if any consistency in the seasonal movement of the prices of specific grades from year to year.

Available information on prices by grades is not entirely satisfactory. When buyer's grades are used there is the possibility that these grades are determined somewhat by the prices paid rather than by the quality of the tobacco. On the other hand, where attempts have been made to gather prices on specific qualities of tobacco, the range of qualities included in any one class is so great that considerable variation in quality within the class may take place and therefore affect the average price for that class.

When analyzing the rather broad classifications of qualities used in the daily quotations radiocast from the Lexington market, it was found that class prices tend to follow the general market average but with much less variation thruout the season. From the number of these quotations procured it was possible also to get an estimate of the seasonal change in the average quality of tobacco delivered to the market. When allowance was made for this variation in quality practically all of the usual seasonal movement of burley tobacco prices was found to

be associated with corresponding seasonal changes in the average quality of tobacco offered for sale. It may be concluded, therefore, that the prices of specific grades and qualities of burley tobacco vary much less during the usual marketing season than the general average market prices would indicate and that much of the seasonal movement of average prices is due to variation in the average quality of the tobacco sold.

Revision of Early Price Data on Tobacco. Prior to 1917, the "farm price" of burley tobacco, as published by the U. S. Department of Agriculture, was based on reports from growers and others as of December 1 of each year. Inasmuch as the tobacco markets in Kentucky and Tennessee usually are not well established at that time and frequently not even open, it is apparent that "December 1" prices might vary considerably from the season's average sales prices. To establish a more adequate series of prices, therefore, market reports published in newspapers and the reports of warehousemen to the State Commissioner of Agriculture were studied with the result that substantial changes in the prices for some of the earlier years were made. In most cases these changes were due to an upward trend or a downward trend in prices after December 1. This series of prices has been established for use in the analysis of factors influencing the price of burley tobacco. Incidental to this it was possible also to secure a series of prices of burley tobacco sold on the hogshead market in Cincinnati from 1899 to 1912.

Distribution of Tobacco Stocks by Groups of Grades. An analysis of stocks of tobacco by groups of grades as reported to the Bureau of Agricultural Economics emphasizes the need for more detailed information. For burley, about 55 percent of total stocks falls in the "Leaf and Filler" group, and no information as to the relative qualities is available. On the other hand, only about three percent of total stocks falls in the three groups, "Wrappers", "Scrap" and "Non-descript". In Green River, about 90 percent of the stocks falls in two groups. In two of the fire-cured types, 60 percent falls in the heavy-leaf group, while in One Sucker and Henderson Stemming stocks a some-

what wider distribution exists. Altho some changes in the distribution of stocks of tobacco in the different groups, have taken place during the four years in which this information has been available, the relative consistency of the distributions, in spite of rather marked changes in the qualities produced, indicates that this classification of tobacco stocks is not accomplishing all that was expected.

Geographical Variation in Tobacco Production. From reports collected by the State Tax Commission in 1932, a comparison of the change in acreage of tobacco on specific farms, from 1931 to 1932, was studied. When tabulated by counties the changes varied from practically no change to a reduction of over 40 percent. In general, the percentage change in the acreage of burley tobacco from 1931 to 1932 was least in the heart of the producing area and greatest in the outlying counties. No attempt was made to weight these changes according to the production in the respective counties, in order to determine the relative importance of changes in total production in the different areas.

Refinement of Tobacco Disappearance Data. It has been customary to measure the amount of tobacco consumed or exported from year to year by subtracting from the total supply at the beginning of the year, the amounts remaining on hand at the end of the year. In doing this, no allowance was made for losses in weight from redrying, stemming, etc. In calculating the disappearance of tobacco during a period of several years, this practice resulted in no difficulty because disappearance, of necessity, must equal production, except in so far as stocks accumulate. When comparing disappearance from year to year, however, the lack of adjustment for losses in redrying and stemming may lead to erroneous conclusions because such losses are greater for large crops than for small ones.

To account for these factors, estimates were procured from several dealers and manufacturers from which conversion factors for stemmed and redried tobacco could be determined. The annual disappearance of burley tobacco when calculated from stocks adjusted for redrying and stemming losses, shows some-

what more regularity than when calculated from unadjusted stocks. In several cases year to year changes become quite different. For example, by the usual method of calculation, disappearance was 21 million pounds less during the twelve months ended October 1, 1933, than during a corresponding period a year earlier. When adjustment for losses in redrying, etc., was made, however, disappearance was decreased only 9 million pounds between these two years. From 1931 to 1932 the new method showed a decrease in disappearance of 3 million pounds while the method usually followed gave an increase of 11 million pounds. Since 1930 the former method indicated a decrease in disappearance followed by an increase and then another increase. The new method, on the other hand, showed decreases in all three years, which was nearer what might be expected. Disappearance by six-month periods, from April 1 to October 1, calculated from stocks reports alone, also checked closer with the newly constructed disappearance figures.

Variety Tests and Rotation Experiments with Tobacco.

The popular varieties of White Burley, Kelley, Judy, etc., widely grown in the Burley district, were included in the tests made of tobacco. These varieties are so much alike in all characteristics that there is little choice among them as to yield and quality. None is resistant to black root-rot. Kentucky strain No. 5 compares favorably in quality with the best of the non-resistant strains and is practically immune to black root-rot.

The outstanding feature of the rotation experiments with tobacco was the constantly increasing benefit in recent years, from the use of manure, both in increasing the yield of leaf and in improving quality. In the 4-year rotation of (1) tobacco, (2) wheat, (3 and 4) orchard grass and clover, in which 10 tons of manure were used on the tobacco, the average value of the tobacco in 1932 was \$223.50 an acre. Where 500 pounds of complete fertilizer per acre was used instead of manure, the value was \$136.80 per acre. Where no manure or fertilizer was used, the value was \$99.90 per acre. There has been a steady improvement in quality in recent years in the tobacco grown after corn in the rotation of (1) corn, (2) tobacco, (3 and 4)

alfalfa, and in the rotation of (1) corn, (2) tobacco, (3) wheat, and (4) clover. In these rotations, manure is applied to the corn and a complete fertilizer to the tobacco. Lime has not been applied on the alfalfa plots for several years, and the inferior quality of leaf produced in the earlier years of the experiment seems to have been due largely to the lime rather than to the alfalfa.

In the three-year rotations, no manure is being used, but the tobacco receives 500 pounds an acre of complete fertilizer. The tobacco in the rotation of (1) tobacco, (2) wheat, (3) clover, was of better quality and yield than that in the rotation of (1) tobacco, (2) wheat, (3) lespedeza, while the wheat, grass and tobacco rotation produced the lowest yields and quality.

Chlorosis in Turkish Tobacco. Soluble manganese was found to produce a chlorosis of the leaves of Turkish tobacco. Plants (Turkish tobacco) were grown in soils from check, limed and phosphated plots from outlying soil experiment fields. The toxic condition developed only in the unlimed soils and was much reduced by phosphate treatments. Plants grown in water cultures developed a similar condition when manganese was 15 p. p. m. and above. Removal of phosphorus in the culture solution lowered the manganese concentration at which injury took place. Soluble manganese was determined in water leachates from additional portions of the soils used in the soil plant experiments, after being incubated two weeks in the greenhouse. The amount present was equivalent to from 6 to 122 p. p. m. of dry soil of the check plots in the various fields. Lime treatments greatly reduced the amounts. Phosphate reduced the amount somewhat. No aluminum, or only a very small amount, was found in the leachates. The plants grown in the experiments were analyzed for manganese. There was general correlation between the extent of plant injury, percentage of manganese in the plants and amount of manganese in the leachates. Plants grown in water cultures suffered no injury from a pH as low as that of the unlimed soils. Plants grown in water cultures containing aluminum were affected thru injury to the root systems, but no symptoms developed similar to those

in the plants grown in the soils. The reduction of injury by phosphate appeared to be partly due to its rendering inactive the manganese within the plant.

Tobacco Mosaic. To test the extent to which tobacco mosaic may originate from overwintered tobacco stalks, stalks of tobacco plants inoculated the previous summer with yellow mosaic and green mosaic, were chopped up, spread on two separate plots, and disked in shortly before tobacco was set. In an adjacent check plot 368 plants remained healthy for 83 days when the experiment was discontinued; 1.5 percent of the plants developed yellow mosaic and 3 percent, green mosaic in the yellow mosaic plot; and 6.5 percent developed green mosaic in the green mosaic plot. Further tests were made to determine whether mosaic is carried over winter in the roots of infected plants left in the field and transmitted to plants set in this soil. Results in 1933 showed that it was not.

Tobacco mosaic was transmitted to 79 percent of plants wormed while leaves and hands were wet and hands were contaminated with fresh mosaic material, and to only 6 percent of plants handled while leaves and hands were dry but contaminated. To determine the spread of mosaic during topping, plants were topped after rubbing the hands with fresh mosaic material and allowing them to dry. Fifty-seven percent developed mosaic. When the hands were then washed with soap and water twice, 2 percent mosaic resulted in plants topped subsequently. Mosaic infection when tobacco was half grown (1932 tests) reduced the weight, length, and quality of Burley tobacco markedly. When inoculated at topping time (1932, 1933) (some flowers blooming) weight was not affected, but there was found to be a definite shift in grades, a larger proportion of the mosaic tobacco grading lugs and less grading bright leaf than in the healthy tobacco. This is considered an advantage in Burley tobacco.

Fusarium Wilt of Tobacco. In an attempt to develop varieties of White Burley tobacco resistant to *Fusarium Wilt*, 1025 F_2 hybrids between resistant Turkish tobacco and susceptible White Burley segregated into 272 resistant and 753 susceptible, when

inoculated and set in the field, indicating that resistance is a simple Mendelian recessive. Tobacco varieties found to be practically immune to *Fusarium* are Pennsylvania Havana 18, Turkish, and the so-called nicotine-free Havana and Cuba tobaccos developed by Dr. Baur, Berlin, Germany.

Angular Leafspot and Blackfire of Tobacco. In an attempt to control the bacterial disease, angular leafspot of tobacco at the Western Kentucky Substation, all seed was treated in 1:1000 silver nitrate solution and dried without washing, clean canvas was used on beds placed in a new site, the beds were sprayed twice with 2-3-50 Bordeaux and appeared to be entirely free from leafspotting. A study of leafspots which developed during the summer proved that the angular leafspot organism, *Bact. angulatum*, was present in some of them. Except in one plot, tobacco was not grown where tobacco had been the previous year. Extensive inoculation studies with *Bact. angulatum* and *Bact. tabacum* prove that resistance develops to a point of practical immunity as tobacco leaves grow older. The change from a high degree of susceptibility to resistance occurs in seedling plants in the course of a few days. Attempts to produce blackfire in dark-fired tobacco by inoculation with *Bact. angulatum* failed, altho weather conditions were ideal and blackfire was developing during the course of the experiment. In extensive inoculation experiments the seed of tobacco was found to remain free from *Bact. angulatum*, with few exceptions, when pods were inoculated as many as 17 times during their development, if inoculation ceased before the pods had split open. Further experiments have confirmed earlier results indicating that a disease quite similar to, if not identical with blackfire may be produced in the greenhouse without the intervention of bacteria. The fact that the lower leaves of tobacco are most resistant to *Bact. angulatum* and most susceptible to blackfire is further confirmation that the diseases are of distinct origin.

Frenching of Tobacco. Field experiments on the effect of pulverized limestone and fertilizers on frenching of tobacco were started at the Campbellsville Soil Experiment Field. No results were obtained during the year, since frenching appeared

in none of the plots. Considerable frenching developed again in limed plots in the regular tobacco experiments. Nitrogen and potassium treatments each reduced frenching somewhat. An extensive pot experiment is in progress to determine whether a deficiency of one of the rarer elements is or is not related to frenching of tobacco.

Electrically Heated Soil for Raising Tobacco Plants. To determine the cost and benefits, if any, of raising tobacco plants in electrically-heated soil, plants were raised on a continuous strip of land divided into three beds by wooden frames. Two of the beds were equipped with electrical heating appliances and the check plot was unheated. The tobacco seed was not sown in the beds until April 8. The plants in both the beds heated by electricity grew very rapidly and at an equal rate and much more rapidly than in the unheated bed. The heated beds required considerably more water than the unheated bed. The tests proved that plants can be produced much more quickly when supplied with artificial heat. By using heat, plants probably would be ready for transplanting by the first of May, or at any desired time between the first of May and the first of June. The question is whether this early planting would be of any particular value. There was no evidence that plants produced in heated beds were of any better quality or grew off any better than the plants from unheated beds.

Commercial Products from Low-Grade Tobacco. An investigation was undertaken to ascertain if cheap grades of tobacco contain any substances that can be converted into commercial products. Thus far, complete analyses have been made on 14 samples of low-grade dark tobacco which were estimated to have a market price ranging from 60 cents to \$1 per hundred. The results of the analyses show that these tobaccos have an average nicotine content of 4 percent, or 4 pounds of nicotine per 100 pounds of tobacco. The retail price of nicotine as quoted on the market is \$15 per pound. Therefore, tobacco which sells for no more than \$1.00 per 100 pounds, contains \$60 worth of nicotine alone. In removing the nicotine from this grade of tobacco, about 4 percent of fatty substances can be re-

covered and converted into soap, perhaps. There still remains 15 to 20 percent of resins in the nicotine extract which can be recovered and probably be converted into a commercial product. The residue of tobacco from which the nicotine, fat and resins have been removed, contains considerably more nitrogen, potassium and other mineral constituents than the original tobacco and its value for fertilizer is enhanced accordingly. However, since this tobacco is free from nicotine, fatty acids and resins, possibly it could be used as a basis for making very mild cigarettes and smoking tobacco. The flavor and aroma could be modified by certain chemical compounds according to the demands of the trade. Researches concerning methods for the separation of fats, resins and gums are in progress.

Wheat. This year, for the first time, several of the bearded varieties of soft winter wheat yielded much better than the beardless varieties. The test included all important varieties of soft winter wheat, both bearded and beardless, grown in the United States, and several hard winter varieties. Comparative yields of some of the most widely grown soft winter varieties are as follows:

Bearded		Beardless	
	Bus per A.		Bus per A.
Fulcaster	32.5	Poole	26.5
Red Rock	35.5	Red May	24.9
Rudy	33.9	Trumbull	24.6
Nabob (Nigger sel.)....	34.9	Harvest Queen	20.7

The much larger yield of these bearded varieties in 1933 was probably due to resistance to a disease or diseases, believed to be root-rot, which, has affected wheat on the Experiment Station farm more or less for several years. Affected plants produced slender, darkened heads, containing few grains or none. It may be that this is the disease to which the bearded varieties are resistant. If tests continue to show the superiority of the bearded varieties, they may supplant most smooth varieties now grown in the state. In the winter-hardiness plots, no winterkilling occurred during the winter of 1932-33, even with such very tender varieties as Purple Straw and Leap's. In

the breeding work with wheat, among some recently selected pure-line strains, one is outstanding for quality of grain. In fact, this year, it produced the highest quality of grain of all the varieties and strains grown on the Experiment Station farm. It has not been tested long enough to determine definitely its yielding capacity, but so far has yielded as well as standard varieties.

Corn. Tests in the breeding work included hybrids produced by crossing one of the best selfed strains with the open-pollinated varieties of corn grown in Kentucky, such as Boone County White, Hickory King, Pride of Saline and Neal's Paymaster. These top crosses gave considerably sounder corn than the open-pollinated parent. The selfed strain used was Kentucky 39, a rather tall-growing, slender strain and quite productive for a selfed-strain. Wherever this strain is used, it gives increased soundness in the progeny of the cross. In some instances, the yields, too, were better than from the open-pollinated parent. The yields of several open-pollinated varieties and of the hybrids produced by crossing the varieties with Kentucky selfed strain No. 39 are given. These are yields on adjoining plots and are fall weights:

	Bus. per Acre		Bus. per Acre
Boone County White..	84.0	Boone Co. White X 39	89.1
Pride of Saline	81.4	Pride of Saline X 39..	90.0
Neal's Paymaster	89.1	Neal's Paymaster X 39	98.6
Jarvis' Golden Prolific	67.4	Jarvis' Golden Prol.	
Iowa Silver Mine	66.4	X 39	94.7
		Iowa Silver Mine X 39	75.4

Eighteen double crosses produced from selfed strains were tested in the field this year. Most of them made as large yields as any of the open pollinated varieties, but were not equal to some of the single crosses in yield or soundness. The largest yield of any hybrid was produced from a double cross which included as one of its members open-pollinated Boone County White.

Corn Ear Worm. Tests for the control of the corn ear worm, which infests sweet corn, by mechanical methods have

been carried on. Pinching the tips of the ears about the time pollination was complete and again two weeks later reduced the damage from worms about 50 percent. Clipping the silks and husks that protrude beyond the tip of the ear, just after pollination was completed, resulted in practical control of worms. These inexpensive methods of controlling the corn ear worm appear to be practical for the home gardener and an attempt will be made to develop them for use in commercial plantings.

Cornstalks for Hotbeds. Dry, shredded cornstalks, packed in a hotbed and thoroly wet down, were found to be a satisfactory substitute for horse manure as a heating material. The decaying cornstalks produced a more uniform temperature and continued to produce heat longer than did the horse manure. The addition of cottonseed meal to the cornstalks hastened and increased the development of heat.

Kentucky Bluegrass. Continuation of the studies of the life history of Kentucky bluegrass (*Poa pratensis*) revealed that while this grass actively reproduces vegetatively only after it matures its seed, new plants may stool more or less extensively, depending, apparently, upon the favorableness of environmental conditions. At no time during vegetative reproduction was leaf growth so great, however, as during the period before seed production.

Excellent stands of common legumes were obtained from sowings made during March, in short but heavy bluegrass sods, showing that the legume portion of a bluegrass pasture can be renewed if conditions are reasonably favorable. Sodds in which no legumes were associated with the bluegrass have become thinner and more weedy each season, whereas those that contained legumes as recently as four years ago, are heavy and largely free of weeds.

Studies of progeny of open-pollinated heads of Kentucky bluegrass indicate that it is from 80 to 100 percent self-fertilized, under field conditions. If subsequent studies support the evidence already obtained, indicating that this plant is not only self-fertile but also largely self-fertilized in the field, the pro-

duction and maintenance of superior strains and varieties should not be especially difficult.

Red Clover. Variety tests of Kentucky-grown clovers continued during the year yielded further evidence regarding the relative suitability of these clovers for the State. Farmers of the State sent in four new varieties for including in these tests, bringing the total number of old Kentucky clovers received to 98. Lots from other states and from foreign countries, grown in comparison with adapted Kentucky clovers, were again decidedly inferior in the spring and summer of the second year. Adapted Kentucky clovers had perfect stands for producing the hay crops, whereas northern clovers had stands but two-thirds as good, and clovers from western United States and from foreign countries had stands one-fifth as good. The respective yields from two crops were approximately 5700 pounds, 4000 pounds and 2000 pounds of barn hay per acre. Adapted and unadapted clovers sown in the spring of 1933 on the Campbellsville soil field, on soils receiving different fertilizer treatments, differed distinctly in vigor and stand by the end of the summer on all plots, but more widely on the poorer soils than on the most productive soils. These differences appeared to be due wholly to less ability of the unadapted clovers to remain semi-dormant during a hot, dry period. It appears that heat injury may be another cause of clover failure in Kentucky.

Microchemical studies of roots of adapted and unadapted clovers show that both kinds contain large amounts of starch in the fall and that this substance becomes gradually less during the winter. The relative rates of utilization (probably mainly in respiration) in the two kinds of clover are significantly different, however; the starch content of the unadapted clovers disappears by the middle of February, whereas the adapted clovers contain a goodly amount at that time and even appreciable amounts when spring growth begins. This and other but somewhat similar evidence is leading us to a broader conception of adaptation than we have hitherto held, namely that unadapted clovers are unsuited to our environment not only because of their genetic constitution but also because our en-

vironment throws them out of their normal physiological balance.

All red clovers, sown in 1933 on a piece of land which had been in the crop since the fall of 1930, showed great loss during the late spring and early summer, in contrast to the good condition of red clovers of the same varieties on a contiguous piece of land that had not grown clover recently. It is believed that this form of failure is similar to, if not identical with, that usually observed in somewhat milder form in first-year clover in a 3-year rotation on the Experiment Station farm.

Seed was saved for the first time from three-year-old red clover plants, in the selection work begun under field conditions in 1931 on the Berea soil field, for the purpose of developing a perennial type of red clover.

Diseases of Red Clover. The study of clover diseases with reference to the part which they play in adaptation of varieties was continued. Cultural studies of *Sclerotinia trifoliorum*, using several cultures from each of several apothecia, indicate a high degree of uniformity between cultures (not single spore) from the same apothecium but wide variation in sclerotial size, number, and position and presence or absence of microconidia, between cultures from different apothecia. Masses of microconidia were produced on the surface of some sclerotia simultaneously with the development of stipes, when these were produced, in test tubes placed out-of-doors in the fall.

Black Stem of Red Clover. The inciting organism of this disease was described as a new species, *Phoma trifolii*. During an extended wet period in the spring, it was found to destroy stands of unadapted red clovers, which have come thru the greater part of the winter in excellent condition. A full report on the Black Stem of Red Clover is given in Bulletin 339.

Colletotrichum. Strains of red clover from various parts of the United States and Europe and adapted clovers from various parts of Kentucky, were inoculated when a month old with pure cultures of *Colletotrichum trifolii*. The Kentucky clovers proved to be highly resistant as compared with other clovers, except Tennessee anthracnose-resistant which was only slightly

less resistant than Kentucky 101. These two last named clovers grown in Western states produced a higher number of susceptible plants than seed raised in Kentucky and Tennessee, respectively. First-crop shoots of first- and second-year Kentucky adapted clovers proved highly susceptible to *Gloeosporium caulivorum* but plants were not killed. *Colletotrichum destructivum* has proved to be a rather common fungus on clovers and alfalfa in Kentucky but tests and field observations have shown it to be only mildly pathogenic on red clovers from various regions. *Colletotrichum cereale* frequently is found fruiting on dying and dead clover plants.

Blackpatch of Clover. A disease of clover, apparently undescribed previously, has been observed for several years. The name, blackpatch, is suggested because of its similarity to brown-patch of grasses. It is caused by a septate, dark brown, sterile fungus of large diameter, which grows over the surface of the leaves, penetrating here and there to produce a large, black lesion. It occurs on white and red clover, in distinct patches, in damp weather, or on individual plants under less favorable conditions.

Resistance of Red Clover Leaves to Puncturing. The resistance of the leaves of a Kentucky and an Italian red clover to puncturing was compared. By puncturing 500 leaves of each, it was found that the average Kentucky red clover leaf is more difficult to puncture than the average Italian red clover leaf. Since the Kentucky red clover leaves offer greater resistance to needle-puncturing, it is assumed that they offer greater resistance to puncturing by the leaf-hopper. This study is being continued and four clovers are being used for the test.

Clover Root Curculio. This insect was studied again thru the season of 1933. It has not been numerous in the field during the past two seasons and should be considered of minor importance at present, but a potential pest of importance to clover and alfalfa. Beetles placed on seedling clover and alfalfa plants frequently gnawed and injured them so severely that the plants made poor growth, or were killed. In 35 tests in the laboratory,

where beetles were confined upon seedling and larger plants, the infested plants made less growth and weighed less than their corresponding checks. In the field, where beetles were placed in cages upon clover and alfalfa, the losses due to injuries were considerable, ranging from 8 to 20 percent. There was practically no difference in losses suffered by fall-sown and spring-sown clover.

Spring Dying of Sweet Clover. Death of sweet clover during the spring of its second year, soon after growth commences, has been prevalent for several years in the Ohio Valley region. Specimens collected in Fleming and Grant Counties, Kentucky, and specimens sent from Illinois and Ohio, all were found to have a decay of the upper portion of the taproot caused by a Pythium-like fungus. This was obtained in pure culture, and in inoculation experiments in the field and greenhouse caused the typical injury.

Alfalfa Failure. Grazing a portion of a field of alfalfa during late winter and spring with sheep produced a first crop of alfalfa hay free from "black stem" disease, in contrast with the ungrazed alfalfa in the remainder of the field, which was appreciably lowered in quality by the disease. The grazed alfalfa was free from weeds, while the ungrazed portion contained many weeds in the first crop.

Legumes in Rotation. In a study of the effect of various legumes in 3-year rotations with corn and wheat, the unlimed and unfertilized check plots were sown with a mixture of red clover, alsike clover, common lespedeza and Korean lespedeza. For those rotations with lespedeza only for the legume, a mixture of common and Korean was used for the first four crops, and Korean for the last two crops. A tabulation is given of the yields and increases for some of the rotations. The results are in harmony with other experiments in showing that soybeans and cowpeas removed from the land lower its productiveness, as compared with such legumes as clovers and lespedeza.

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Plot No.	Third-Year Crop	Soil Treatment*	Hay, Lbs. 6-Yr. Ave.	Increase	Corn, Bus. 5-Yr. Ave.	Increase	Wheat, Bus. 5-Yr. Ave.	Increase
1	Check	O	825	.....	33.5	.....	5.1	.....
2	Lespedeza (Under)	P	.....	.....	47.1	.....	11.6	6.1
3	Lespedeza hay	P	2223	1297	41.0	.....	10.7	4.9
4	Check	O	977	.....	35.5	.....	6.2	.....
5	Lespedeza hay	LP	3787	2776	54.2	.....	13.7	7.4
6	Cowpea hay	P	3657	2611	37.1	.....	8.6	2.2
7	Check	O	1080	.....	40.6	.....	6.5	.....
8	Soybean hay	P	3333	2123	40.3	.....	8.6	1.7
10	Check	O	1530	.....	42.0	.....	7.8	.....
11	Sweet clover **	.....	1987	459	61.0	.....	15.0	7.9
13	Check	.....	1523	.....	41.5	.....	5.8	.....
16	Check	O	1210	.....	38.0	.....	6.8	.....
17	Red-alsike hay	LP	3220	1853	60.3	.....	18.0	10.3
18	Red-alsike (Under)	LP	.....	.....	63.0	.....	18.6	10.1
19	Check	O	1680	.....	43.6	.....	9.4	.....
20	Red-alsike hay	MLP	2790	1288	61.6	.....	18.6	10.0
21	Timothy	LP	1917	592	44.8	.....	10.5	2.7
22	Check	O	1147	.....	35.6	.....	7.1	.....

* P = superphosphate; L = limestone; M = 3 tons manure on corn for each ton of clover previously harvested.

** Sweet clover cut for hay the fall of year of seeding. Seed saved the next year and straw returned. Annual average, 180 pounds of seed in hull.

Soil Experiment Fields. The plans for the Lexington soil experiment field were radically changed at the end of the cropping season of 1931. The rotation for 21 years had been corn, soybeans, wheat and clover. It was changed to corn, wheat, and alfalfa for two years. The cornstalks, soybean straw and wheat straw had been returned a large part of the time in the former rotation. Manure now is used at the rate of 8 tons per acre on the corn. All plots that had not been limed in the previous rotation were limed at the rate of 2 tons per acre, the fertilizer treatments remaining the same.

For the two years since alfalfa was introduced into the rotation the average yield of hay was 3.9 tons per acre per year. The best average annual yield of clover for any two consecutive years in the previous rotation was 2.4 tons per acre, and the best average annual yield of soybean hay for any two consecutive years was 2.6 tons per acre. Since alfalfa occupies the same proportion of the land as the clover and soybeans in the former rotation, it has produced 7.8 tons of hay, as against 5 tons for the clover and soybeans. Not only has the alfalfa made 2.8 tons more hay a year, but there has been the advantage of only one breaking of the ground in four years instead of two, and the expense of the cover crop following soybeans has been eliminated. The alfalfa could have been cut the fourth time, but this growth was left on the ground.

The value of good soil management and the importance of lime and phosphate fertilizers are again shown in the results from the various soil experiment fields as tabulated below:

KENTUCKY SOIL EXPERIMENT FIELDS, 1933 CROP YIELDS
PER ACRE

Field	Corn, Bus.			Wheat, Bus.			Grass and Legume Hay, Lbs.		
	O	M	MLP	O	M	MLP	O	M	MLP
Berea	7.3	26.9	52.7	No wheat grown			1095	1904	4880
Fariston	3.4	12.3	54.9	0.3	4.1	12.9	000	000	7100
Campbellsville	16.0	48.7	72.1	2.3	5.8	20.2	870	2750	5140
Greenville	18.8	29.5	65.5	0.7	5.8	16.7	1060	1865	4320
Mayfield	29.3	52.9	67.4	3.0	7.1	15.7	1785	2460	5320

O = No fertilizer, M = Manure, MLP = Manure, limestone and superphosphate.

On the Berea, Greenville and Mayfield experiment fields, from 1913 to 1930, superphosphate was applied in amounts that averaged 160 pounds per acre per year, 200 pounds per acre being used in the earlier part of the period and 100 pounds in the latter part. Rock phosphate was used in comparison at twice the rate for superphosphate. Since 1930, inclusive, the phosphates have been left off of half of some of the plots and continued on the other half. The average yields were as large where the phosphates were omitted.

Rate-of-Liming Experiments. Plots set to tobacco in 1932 had been limed in 1928. The quality of tobacco leaf on all the heavily limed plots was better in 1933 than in previous years, indicating that the injurious effects of the lime are gradually disappearing. In fact, in 1933, the quality seemed to be affected only where more than five tons an acre had been ap-

plied, while yields were not reduced even on the heaviest limed plots. Wheat seems to be the least affected of any of the crops grown in this rotation (corn, tobacco, wheat and clover) by heavy or excessive amounts of ground limestone. Corn shows some reduction of yield on the heaviest-limed plots. Red clover still shows a reduced vigor and growth on the plots which received very heavy applications of limestone.

Fertilizer Tests. These tests consist of the treatment of sandstone land with limestone and various fertilizers applied in various ways in a rotation of corn, wheat and mixed legumes and grasses for hay. Averages of triplicate tests for each fertilizer treatment on each crop each year, on limed land, and one set of similar fertilizer tests on unlimed land, are given in the following table:

Treatment	Corn, Bus. Ave. 4 Crops		Wheat, Bus. Ave. 4 Crops		Hay, Lbs. Ave. 3 Years	
	Limed *	No Lime	Limed	No Lime	Limed	No Lime
No treatment (check)	25.3	24.7	2.4	2.3	1927	1333
Superphosphate	43.3	36.8	11.0	10.0	3307	2253
Superphosphate and potash	43.4	37.7	11.2	9.2	3229	2280
No treatment (check)	23.8	27.3	2.8	3.3	1351	1330
Superphosphate and nitrate of soda	41.7	38.9	16.4	15.7	3353	2600
Superphosphate, potash and nitrate of soda	44.1	40.1	15.3	16.0	3271	2760
No treatment (check)	21.6	30.3	2.2	3.1	1181	1467

* Check plots not limed.

Tomatoes. Further work was done on the effect of organic matter, sodium carbonate, and ground limestone on the yield of tomatoes. A field test was set up on a clay soil of moderate fertility. Ground limestone and sodium carbonate were used

for alkali treatments and dry cornstalks and green rye were use to supply organic matter. The results were as follows:

Treatment Tons per Acre	Yield of Tomatoes Tons per Acre
Cornstalks, 8; ground limestone, 9; sodium carbonate, $\frac{1}{2}$	10.2
Cornstalks, 8; ground limestone, 9	7.4
Cornstalks, 8	6.7
Green rye, 20; ground limestone, 9; sodium carbonate, $\frac{1}{2}$	5.5
No fertilizer	4.4
Ground limestone, 8, sodium carbonate, $\frac{1}{2}$	1.3

The large amounts of alkali used were required to bring the acid soil to a neutral or alkaline reaction favorable for nitrification. The results show that alkali treatment without organic matter was detrimental; that the yield of tomatoes was greatly increased over that of the check when limestone and dry cornstalks were used together and that sodium carbonate added to the limestone and cornstalks stimulated a further increase in yield. The cornstalks alone increased yield, but not so much as when used with limestone. The use of dry cornstalks and ground limestone was effective in building up the clay soil used in this test. The results from the use of sodium carbonate indicate that this material may prove to be a valuable supplement to limestone, but its cost and its effect on the physical condition of the soil render it unsuitable as a substitute for limestone.

Setting Tomato Plants in Groups. A comparison was made of tomatoes planted in groups, 4 plants in a 2x3-foot area, each group separated by 6 feet from the next, on all sides, with the usual plantings of 4x5 feet. The group planting produced 30 percent more marketable fruit early in the season (July). The advantages from group planting seemed to be reduction of damage from sunscald and from the rotting of fruits that came in contact with the soil. An increase in early yield is important

because the price level is relatively high at that time. Total yields for the season were practically the same for both methods.

Effect of Growth of Tomato Plants in the Plant-Bed on Total Yield. Tomato plants usually are grown in a crowded condition in the plant-bed. This results in a stunting of growth and a loss of roots at the time they are set in the field. A test was made to determine the effect, if any, of plant-bed conditions on later development and yield. Plants grown in plant-beds or pots, so that each plant occupied a surface area of about 10 square inches and a soil depth of at least 3 inches, produced approximately 40 percent greater total yields than plants grown in an area of 2x2 inches and a depth of 2 inches. Growing plants in pots was not found superior to growing them in plant-beds if the root system was kept intact by cutting out in blocks at setting time.

Variety Tests of Vegetables. In a variety test including 14 varieties of tomatoes, the Landreth tomato was most productive and the quality was excellent. John Baer ranked second. Stone was third. The widely grown Earliana and Ponderosa tomatoes were the least productive. The new Winsall tomato produced a low yield, but was of good quality and the fruits were smoother than Ponderosa. Pritchard produced the largest early yield, outyielding both Bonny Best and Break O'Day, altho Bonny Best produced a slightly larger total yield. The early yield of Marglobe was good, but they tended to crack worse than the other varieties. Of the sweet corns, Golden Sunrise (B. 30) produced the best crop of good quality roasting ears. Kings-croft Golden Bantam, a new variety, bred to resist Stewart's disease, did not produce well in the 1933 season. The new Katahdin potato, resistant to mild mosaic, produced a large yield, but further trials are necessary to determine its place as a variety for Kentucky.

Cabbage Experiments. A test was made of the response of cabbage to nitrogen in three different carriers; nitrate of soda, calcium cyanamid and sulfate of ammonia. The response from nitrate of soda was markedly better than from the other fertilizers and the yield was practically double that of the

check. Calcium cyanamid increased the yield about 40 percent and sulfate of ammonia about 20 percent.

A large proportion of the cabbage plants used for the early crop are grown by commercial plant growers. Usually, these plants are subjected to cold weather and dry soil conditions to harden them for planting in March, before hard frosts are over. Such plants are severely stunted and it seemed questionable whether they could recover to produce a large yield. To test the effect of plant-bed care seeds were sown February 3 and February 15. The plants from the first sowing were hardened in the coldframe and set in the field March 27. Plants from seed sown February 15 were hardened somewhat and set out March 27. The plants from the earlier sowing produced a low yield and so much time was required to recover from their stunted condition that the crop was late in maturity. Plants from the seed sown February 15 made a good crop.

Effect of Minerals on the Growth of Vegetables. Compounds of copper, boron, iodine, bromine and arsenic were mixed together and added to a definite portion of soil, and enuf of the mixture to contain approximately 0.15 gram of the mixed mineral compounds, per plant, was placed in the rows so that the minerals would be available to the roots of the vegetables. Tomatoes, lettuce, sweetpotatoes, cabbages, turnips, rape, beans and carrots were grown in this way. An equal number of the same kind of plants were grown in an adjacent row without treatments. Four varieties of tomatoes were grown, Red Ponderosa, Yellow Ponderosa, Stone and Golden Queen. The tomato plants of all four varieties showed a marked increase in growth from the mineral treatment and the yields were increased approximately as follows: Red Ponderosa, 21 percent; Yellow Ponderosa, 33 percent; Stone, 18 percent and Golden Queen, 73 percent, over the untreated plants. All the other treated vegetables gave increased yields except sweetpotatoes which produced approximately the same yields as the untreated plants.

Rabbits fed on the treated cabbages made faster and larger gains in weight than rabbits to which equal amounts of the untreated cabbages were fed. Chemical analysis of the treated

and untreated vegetables showed that the treated vegetables contained more of the elements added to the soil than the plants that grew in the untreated soil.

Potato Fertilizer Tests. In 1929 tests on the effect of certain fertilizers on the yield of potatoes were started. The potatoes were planted on a medium fertile brown silt loam, on the experiment station farm. One-fortieth-acre plots in replications of four were used. Every third plot was a check and the increases were calculated from the closest check. One-half of the entire area was seeded to mixed clovers every other fall, and turned under in late May for the next fall and spring crops. The following table shows the increases in bushels per acre, for each treatment. The figures are averages of four replications for each of five fall crops and four spring crops:

Fertilizer in Lbs. per Acre	Spring Crops	Fall Crops
500 lbs. 3-8-6	20.2 bu.	13.0 bu.
1000 lbs. 3-8-6	18.1 bu.	11.2 bu.
1000 lbs. 3-0-6	20.8 bu.	8.9 bu.
1000 lbs. 3-0-0	20.4 bu.	0.4 bu.
1000 lbs. 4-8-6	30.6 bu.	10.9 bu.
1000 lbs. 6-8-6	35.5 bu.	8.9 bu.
1000 lbs. 3-8-20	26.7 bu.	20.1 bu.
1000 lbs. 3-8-6 and 1 ton of limestone...	19.1 bu.	13.7 bu.

On the soil used in this experiment nitrogen in the fertilization was profitable only for the spring crop, while potassium was valuable for both spring and fall crops. The use of phosphorus on this phosphatic soil showed no effect and the addition of lime was of no apparent value.

Berries. Three varieties of strawberries recently introduced by the U. S. Department of Agriculture were put out for trial, the Bellmar, Southland and Red Heart. All these showed promise in the first season's test, as varieties of value for the home garden or local market. Other varieties tested were: Howard Supreme, Kanner King, Early Richmond, Keith No. 2, Keith No. 63, Keith No. 84, and St. Louis No. 1, none of which exhibited special merit.

The "Young" dewberry was killed back so severely by winter injury in the past four years that the crop was a failure each year. Unless a satisfactory method of winter protection can be worked out it seems to have no place in Kentucky.

Rooted tips of the Cumberland and Quillen varieties of black raspberries, taken from canes that were killed during the winter after the tips were rooted, made as good growth as those from canes that were not killed.

A planting of raspberries was made in 1932 to determine whether disease could be eliminated by cutting off all the stem and completely covering the plants with dirt so that the new shoots would not become infected as they pushed thru the ground. Four rows of de-stemmed plants and four rows of plants with stems were set for trial. The stand from de-stemmed plants was somewhat poorer than from plants with stems, and the de-stemmed plants that grew produced a smaller number of canes for fruiting this season. The yield of berries was about 20 percent greater on the plants with stems intact.

Spraying tests were made to determine the effect of the sprays on the foliage. A spray of liquid lime sulfur at a dilution of 1-10, applied on April 10, caused severe foliage injury and stunting of growth. Bordeaux mixture at standard strength caused no foliage injury at any time sprays were applied during the spring or summer. Liquid lime sulfur at a strength of 1-40 and also dry lime sulfur at 4 pounds to 50 gallons of water caused injury to the foliage. The lime sulfur also injured immature berries and resulted in delayed ripening and misshapen fruits. New plants taken when 3 to 4 inches tall (about May 1) and planted in the field, in 1932, made a satisfactory stand but did not make as good growth as well-rooted one-year sucker plants, and the yield of fruit was small.

Raspberry Diseases. A study of the diseases of red raspberry was begun with the object of determining the cause of cane dieback of Latham and Chief red raspberries. In the past two years leafspot has caused severe damage to these varieties resulting in almost complete defoliation and in sensitivity to cold, with death of buds or entire canes during the winter.

Bordeaux spray was found to be beneficial in control of leafspot. It reduced winter killing of canes from about 90 per cent to about 30 percent.

Orchard Tests. The Paducah variety of apple continued to hold its place among the leading varieties in the orchard. The large, attractive fruit of good quality and the productiveness of the trees were noteworthy. A new variety that appears outstanding is Turley. The fruit is large, of good quality and very attractive and, unless defects appear that cannot be foreseen now, this variety probably will become one of the leading varieties for commercial planting in Kentucky.

Cover Crop Test in Young Apple Orchard. Four systems of cover crops were established four years ago on a young apple block: 1. Sweet clover alternating with soybeans; 2. Korean lespedeza; 3. Bluegrass sod; and 4. Spring cultivation followed by millet in summer and rye in winter. The trees in all plots except the bluegrass sod, have made good growth. The trees growing in millet and rye have continued to make the best growth. Determinations made on the soil at various times during the summer (June 12 to November 15) showed that the soil in the millet-rye plot contained more nitrate than that of the legume plots. The trees in bluegrass sod have made poor growth and the nitrate in the soil has been found to be low at all times. Thus far it appears that spring cultivation followed by summer and winter cover crops, is more favorable for good growth of young trees than a permanent legume sod.

Codling Moth. Studies of the codling moth during the past three years have given information not recognized previously. In Kentucky the codling moth usually has three generations, but in some seasons it has four. It is important to recognize this fact because, in the former case, packing-shed sanitation is important. In the latter case it has little value because the worms are all left in the orchard.

Likewise, it is now known that the calyx spray is extremely important most years but that occasionally it may have little value. This fact is correlated with several factors; lateness or

earliness of the spring season, size of apples at the time the first worms hatch, and certain other things less well known. In the spray calendar for codling moth it has been found that a midway spray is sometimes needed between the calyx and first cover sprays.

Spray Tests. For two winter seasons, studies and experiments have been in progress on a new organic emulsifier for dormant spray oils. This new emulsifier reduces spray costs by 10 to 25 percent and utilizes products of the farm. This reduction in cost is in addition to the saving which resulted from the introduction of tank-mixed emulsions now in use by 80 percent of the orchardists in Kentucky. The experiments of 1933 resulted in improvement in the formula and made it possible to develop it to the point where it is adaptable to commercial emulsions.

A study of the use of adhesives in combination with arsenical sprays has been undertaken. Three of the adhesives in common use by commercial growers in Kentucky frequently cause direct or indirect injury. These adhesives are linseed oil, fish oil, and mineral oil emulsions. Investigations of these materials when used with various emulsifiers and saponifying agents for the purpose of making the spray solutions non-injurious are in progress.

In the study of adhesives, it has been found that all soaps and alkalies flocculate lead arsenate and increase its adhesiveness, bulk and, therefore, coverage. When soaps are used, the surface tension of the spray solutions is reduced so that spray solutions and mixtures spread and wet fruit surfaces better.

If lead arsenate is used with materials such as hydrated lime or lime sulfur, the studies indicate best results are obtained when the adhesive, such as soap or oil emulsion, is mixed with the lead arsenate in the spray tank and agitated. After that, the hydrated lime and lime sulfur are added. When this order of mixing was used, sprays did not burn even the tender foliage of peach.

In initial tests of contact sprays, it was found that tar oil from pine contains elements which greatly increase the value

of spreaders when used with nicotine or any of the other contact poisons. In the studies conducted, thus far, pine tar oils are most effective when used with soap, as they increase spreading and wetting power of the soap.

Certain pine tar oil fractions are very toxic in themselves when used with soap, whereas others are neutral in their action or actually reduce the efficiency of the soap. No injury, thus far, has been caused by the pine tar oils, whereas the pine oils do cause excessive injury. The heavy pine tar is not so good as the pine tar oil, since it is too viscous and spray solutions made with it fail to spread as well as those made with pine tar oil.

In studies with leafhoppers, spray combinations containing rotenone, pyrethrum and pine oil were more toxic than nicotine. The combination did not cause nausea among the laborers, whereas the nicotine caused nausea in two cases.

To reduce spray injury to peaches by lead arsenate, a zinc sulfate-lime mixture was tested. It proved very satisfactory and was recommended for the first time during the last spray season.

Leafhopper Studies. The leafhopper appears upon alfalfa in rather large numbers the first week in June and reaches its maximum numbers during the last week of July. No practical method of controlling the insect by insecticides is known. The injury to alfalfa can be lessened, however, and confined almost entirely to the second cutting, by regulating the cutting dates in accordance with certain stages of the development of the insect. By delaying the first cutting to about June 15, many eggs laid by the early-appearing adults will be destroyed and fewer will be laid in the second crop; by delaying the second cutting until the last week of July, the third cutting will escape with little or no injury. The adult hoppers lay fewer eggs after mid-season and consequently do little damage to the third crop of alfalfa if the second cutting is made late in July. Tests in 1933 were made on duplicate plots, one infested and one uninfested, and when the loss from hopper injury in plots cut on June 2, July 10 and August 29 was compared with that in plots

cut on June 15, July 31 and September 16, there was a difference of 12 percent in favor of the later-cut plots.

Grape Leafhopper. Studies of season history of leafhoppers of grape for two years show that in Eastern Kentucky the leafhopper spray should be applied to grapes between June 20 and June 25, for efficient control. Many commercial growers have been getting only a partial control by spraying during late July. Tests showed that nicotine for control of grape leafhoppers should be supplemented by the use of a good soap spreader.

New Weed and Insect Species. A new weed, *Galium pedemontanum*, not known before to exist in the United States, was found on a farm in the Bluegrass area. This weed threatens to be a serious pest in bluegrass pastures. New insects collected include a species of Hymenoptera, genus *Gonatocerus*, parasitic on the Membracid, *Enchenopa binotata*; a species of tropical spider, genus *Ctenus*, and a species of Hymenoptera, genus *Ceratobanus*, parasitic on the eggs of the spider mentioned above.

Service Analyses. Qualitative tests were made on 125 samples of soil sent in by county agents and farmers. These tests serve as a guide in advising the farmer whether it is necessary to apply lime and phosphate to the soil to grow leguminous crops. During the year, 308 samples of limestone and 273 samples of marl were analyzed for their neutralizing value. Fifty-eight samples of well and spring waters were analyzed for total solids and qualitative tests made to ascertain the nature of the mineral matter the waters contained. Tests were also made for the presence of iodine and bromine in the waters and when found, as they usually are, these elements were determined quantitatively. The results show that iodine and bromine, are quite widely distributed in the well and spring waters of this state. Tests were made on 187 samples of miscellaneous materials—mostly minerals.

Iodine Content of Corn Produced in 19 Eastern Kentucky Counties. Samples of corn produced in 19 different counties in

Eastern Kentucky during 1933 were analyzed for their iodine content. Ten of the samples averaged 98 parts of iodine per billion. Four samples averaged 160 parts per billion. Three samples averaged 210 parts per billion. Two samples averaged 650 parts per billion. One sample contained 250,000 parts per billion. The samples containing less than 100 parts of iodine per billion evidently represent corn grown on unfertilized soil. The samples which contained larger amounts than 100 parts per billion probably received a part of the iodine from the fertilizers used. The results indicate that the soil in Eastern Kentucky is low in iodine and the iodine content of corn can be increased tremendously by the use of crude fertilizer materials such as crude nitrate of soda and raw rock phosphate.

Researches on Iodine and Bromine. The iodine content of about 40 samples of limestones has been determined, showing an average of 450 parts of iodine per billion. This indicates that the limestone deposits of Kentucky are fairly well supplied with this element.

The determination of iodine, bromine and chlorine was made on a number of samples of milk and also the feeds which the cows consumed during the time the samples of milk were collected. The results showed that on normal pasture or winter feeds the iodine content of milk is about 30 parts per billion, whereas when iodine is added to the feeds it is increased to as much as 400 parts per billion.

Determination of Fluorine. A new method was worked out for the determination of fluorine in soils, plants and animals. A description of the method, with the results obtained with it, was presented before the Division of Agricultural and Food Chemistry at the meeting of the American Chemical Society at Chicago, in September.

Determination of Carbon and Nitrogen. A method for determining carbon and nitrogen in the same sample was developed and has been found useful for the study of the carbon-nitrogen ratio in plants. The carbon and nitrogen in the sample were oxidized, by means of sodium chlorate and sulfuric acid, to nitric acid and carbon dioxide. The nitric acid

was distilled into water and determined by means of phenoldisulfonic acid. The carbon dioxide was caught by displacement and the amount determined by shaking with standard sodium phenolphthalate solution, color change forming the basis for estimation by a colorimetric comparison. Results very close to the theoretical were obtained for the nitrogen and carbon in pure picric and sulfanilic acids.

Agglutination Tests by the Rapid Method. In the use and interpretation of the agglutination test for the diagnosis of Bangs disease (bovine infectious abortion) it is often found difficult to decide upon border line reactions. In routine testing the generally accepted low dilution is 1-50; the animal being considered positive if the agglutination is complete, suspicious if only partially complete and negative if no agglutination occurs. In 532 agglutination tests done by the rapid method in dilutions of 1-25 there was no agglutination in 444, or 83½ percent. In 64, or 12 per cent, the agglutination varied from a trace to less than complete. In 24, or 4½ percent the agglutination was complete in the 1-25 dilution and in most of these was complete in the higher dilutions. Sixty-three animals in a Bang's disease free herd just tested showed no agglutination, rapid method, in dilutions of 1-25 and above. Our work indicates that agglutination ranging from slight to complete in a dilution of 1-25, with no agglutination in the higher dilutions, is of no immediate significance in eradication work. On the other hand, complete agglutination in a dilution of 1-50 is invariably indicative of infection and must be so interpreted in Bang's disease eradication work.

Hemolytic Streptococci. Study of the differentiation of low-acid-producing, non-sodium-hippurate-hydrolyzing, hemolytic streptococci of human and animal origin has been continued. The biochemical methods of differentiation previously reported have been adopted by the American Association of Medical Milk Commissions and are now included in their methods and standards for the production of certified milk.

It has been demonstrated that *Str. equi*, the sorbitol-fermenting streptococci of animal origin and the trehalose-fer-

menting streptococci of animal origin, while distinct in themselves, fall into one broad serologic group. The strains of human origin compose a second group. There is no cross precipitation between the two groups and the human and animal streptococci can be clearly distinguished by this method. This confirms the earlier differentiation of these organisms based on biochemical characters.

Delayed Conception and Sterility in Dairy Heifers. A study of breeding and health records of the Experiment Station Dairy herd indicates a great difference in the breeding efficiency between different groups of females. Seventy-five services were required for seventeen conceptions among a group of heifers bred for the first time. This is a breeding efficiency of 22.6 percent or an average of 4.41 services per conception. With cows being bred for their second, third and fourth calves, only forty-one services were required for twenty-nine conceptions, or an average of 1.41 services per conception, a breeding efficiency of 70.7 percent. Twenty-three of the twenty-nine cows conceived to one service, but their breeding history indicates that as much difficulty was experienced in getting them in calf the first time as with the heifers mentioned. To determine what factors affect the breeding efficiency of heifers, studies are being made on four groups of heifers under carefully controlled conditions.

Marketing Milk in Kentucky. A study of the milk market at Lexington was started and data for an analysis of sources of supply, market outlets, classes of milk used and other aspects of milk marketing organization were assembled. Preliminary analysis of the data shows that a surprisingly large proportion of the milk is sold at retail by producer dairymen and that the trend toward direct marketing by dairymen has been important in recent years. This tendency appears to be due to the relatively large margins maintained by established milk plants.

Receipts of milk show considerable seasonal variation. During 1932, the amount received by pasteurizing plants increased each month until May, held fairly uniform thru the next

four months, then declined thruout the remainder of the year. During the first 10 months of 1933 receipts showed a similar trend, altho they were approximately 20 percent below receipts during the corresponding period of 1932.

Of the 5,167,213 pounds of milk received by milk plants, for which data on both receipts and use were available, only 2,827,677 pounds, 55 percent, was sold as bottled milk. The remainder was used in other forms of dairy products. The amount of milk used in this form was fairly uniform altho there was some decrease during the summer months. The percentage of milk purchased which was sold as bottled milk amounted to 65 percent in January, 1932. This declined during the next six months and in July only 38 percent of the milk was sold in bottles. During the next six months the percentage increased each month until, in January, 1933, 68 percent was so sold. During the first 10 months of 1933, or until October, the percentage of milk bottled each month followed the same trend as during the preceding year.

Cost of Producing Milk and Butterfat. The data of this study were derived from records kept on 34 dairy herds in 1932 and 1931, in connection with the dairy herd improvement associations. The herds had an average production of 6,840 pounds of milk and 307 pounds of butterfat per cow, per year, as compared with 3,700 pounds of milk per cow, the average for all dairy cows of the state. Feed represented 57 percent of the gross cost of producing milk and butterfat; man labor, 16 percent; depreciation on cattle, 13 percent, and other costs, 14 percent. These figures indicate that the average dairyman should receive about twice the value of feed and pasture consumed by the dairy cows, in order to maintain his herd, provide shelter, get wages for hired labor spent on the dairy cows, and meet other operating expenses. The average gross cost of producing milk was \$1.37 per 100 pounds and the gross income was \$1.73 per 100 pounds. The average gross cost of producing butterfat was 22 cents per pound and the gross income was 25.6 cents per pound.

Cost of Raising Dairy Heifers. Records on the cost of raising heifers in 19 herds showed that (1) dairy heifers were raised to freshening age at a lower cost by feeding by hand than by nurse cows; (2) the use of skim milk to displace much of the whole milk lowered costs; (3) a grain mixture composed chiefly of farm-grown grain was the most economical, and (4) abundant pasture for heifers past the milk feeding period reduced costs.

Steer Feeding. A comparison of soybean hay and alfalfa hay as roughage in fattening yearling steers was made. The soybean hay was cut early—just before the pods were formed—and was cured without rain. The alfalfa hay was of good grade. Two lots of steers, weighing 755 and 740 pounds, respectively, received a full feed of broken ear corn and a limited amount of cottonseed meal and all the roughage they would consume. The test extended thru 142 days. The average daily gain per steer for the lot receiving soybean hay was 2.09 pounds and for the lot receiving alfalfa hay, 2.26 pounds. At the beginning of the test, the steers were valued at \$5.00 per hundredweight. At the close of the test, the lot fed soybean hay was valued at \$5.75 per hundredweight and the lot fed alfalfa hay at \$6.00 per hundredweight.

Cost of Raising Beef Cattle, and Returns. Practices influencing cost and returns for beef cattle herds were studied in records on 11 herds in Union County. This study showed that the farmers who fed grain to the nursing calves, marketed the calves off the teat in the fall, as milk fat, grain-fed, baby beeves, and limited the grain fed to the breeding herd, made a net return of \$8.87 per calf, as compared with a loss of 4 cents per calf by those farmers who followed only one or none of these practices.

Factors Influencing Cost and Returns of the Hog Enterprise. Cost accounts on 13 herds of hogs in Union County showed that the farmers who (1) full-fed their pigs from birth until ready for market (2) practised swine sanitation and (3) raised more pigs than the average farmer of this group, made a net return of 95 cents for each 100 pounds of pork produced,

whereas farmers who failed to follow any of the above practices lost 45 cents per 100 pounds.

Economics of Hog Production in Kentucky. Most of the hogs marketed by Kentucky farmers in 1932 were sold thru terminal markets. The four terminal markets best situated to serve Kentucky hog producers were Cincinnati, Louisville, Evansville and St. Louis, in the order named. Other markets were Nashville, Indianapolis, Pittsburgh, Cleveland and Buffalo. The most complete system of secondary markets in the State has developed in the Bluegrass area where, in 1932, more than 200,000 head of hogs were sold at the twenty livestock auction markets. These auction markets, located in the production areas, serve as concentration points in assembling hogs in carlot, for shipment to eastern packers or to terminal markets. Furthermore, they serve as distributing centers for the feeder classes of hogs produced in the territory. Over half of the graded hogs sold at the auction markets in 1932 were classed as feeders. Part of these were returned to farms in the immediate vicinity, part were shipped to the main corn-producing areas in the states to the North, and part were sold to serum plants in Indiana and Ohio. The fat slaughter hogs were purchased by order buyers representing packers, speculators or local butchering establishments.

Local packing plants are another type of secondary market which has developed in the more concentrated hog-producing area of the western part of the State. Seven packing plants in this area, that buy their supplies direct from farmers, slaughtered about 121,200 hogs in 1932. Three plants, however, do not slaughter the total number of hogs purchased from farmers, as these plants buy all the livestock offered them. If a surplus above demand for local slaughter is acquired it is shipped to terminal markets.

In recent years many local butchers have started purchasing a sufficient number of hogs to meet their requirements for fresh pork. These butchers, who formerly depended upon large packing plants to supply their needs, have endeavored to reduce

their costs by slaughtering hogs purchased directly from the farmers.

During the period since 1903, the long-time trend of hog prices was upward until 1926 after which prices tended to move downward. It would not be correct, however, to conclude that the hog producer necessarily was better off in 1926 than in 1903. Before an accurate conclusion can be drawn it is necessary to know the relative purchasing power of the dollar at the two periods. For example, when hogs sold for an average of \$17.70 per 100 pounds, in 1919, they were not actually worth as much in exchange for other goods as when they sold for an average of \$8.90 in 1910. This is shown when prices received for hogs are expressed in terms of stable money. By dividing each year's price by the index of wholesale prices of all commodities, to reduce them to dollars of equal purchasing power, it is found that in 1919 the price of hogs averaged \$8.76, while in 1910 the average was \$8.64, showing that the 1919 price was only slightly above that of 1910, in terms of the amount of goods that could be purchased with the money received for 100 pounds of pork. Price data for Kentucky are available for only the last few years, but during that time the price of hogs in this State has followed closely in line with central market prices. Price fluctuations in Kentucky are merely a reflection of price variations in the large central markets.

Prices paid for hogs in different sections of Kentucky differ somewhat, but usually show a rather definite relationship to certain terminal markets. At the terminal markets serving Kentucky producers, the prices were highest at those closest to the consuming centers or those terminal markets located farther east. Prices of some of the grades of hogs varied considerably in relation to other grades during different years. The four years studied intensively seemed to divide into two periods of about equal length. In 1929 and 1930 the price of each grade increased with each increase of weight. In 1931 and 1932 the reverse was true, as the two light-weight groups sold for the highest price, while the remaining groups sold lower.

Contaminated versus Clean Ground in Raising Pigs. It is

unprofitable to raise pigs on contaminated lots; that is, areas that have been used for a long time as hog runs. Data collected during the last 9 years showed the number of pigs raised under crowded, insanitary conditions to be 50 percent of the number farrowed. Whereas, under sanitary conditions, the number raised was 76 percent and their average weaning weight at eight weeks of age was greater.

Cost and Profit Margin in Lamb Production. The analysis of the cost account records kept on 28 Owen County farms showed the items entering into the cost of producing spring lambs and the factors most influential in increasing profit margins of the lamb enterprise. Eleven of the 28 farmers raised more than 129 lambs for each 100 ewes and made an average net return of \$2.85 per ewe. Four farmers raised less than 98 lambs for each 100 ewes and made only 46 cents net return per ewe. The flocks that raised over 129 lambs for each 100 ewes had a feed cost other than pasture of \$1.54, as compared with \$1.00 for the flocks that produced less than 110 lambs for each 100 ewes. Even with this higher feed expense, the flocks with the largest lamb crops made \$2.39 more in net return per ewe than those with less than one lamb per ewe.

Eleven farmers who have followed a regular drenching program for 3 years or more made a net return of \$3.04 per ewe, and nine who did not drench made \$2.05 net return.

Lambs from ewes bred before September 15, were marketed early and, usually, brought good prices. The net return per ewe in flocks bred before September 15 was \$2.72 as compared with \$1.87 per ewe for flocks bred after that date.

Acidosis of Pregnant Ewes. Confirming work of previous years, the records demonstrate that in acidosis of pregnant ewes there is a marked disturbance of the calcium and phosphorus metabolism due to improper feeding and to the extra demands made upon the maternal organism during the latter period of pregnancy. This metabolic disturbance is demonstrated by the lowering of the calcium-phosphorus ratio of the blood which in normal pregnant ewes near term, averages 2.4, whereas, in the 45 cases of acidosis observed, this average was 1.1.

The Effect of Feeding Vitamin D Supplements to Chickens. The previous investigations in feeding vitamin D supplements to pullets were repeated with hens which were evenly divided in pens on the basis of their trapnest records. The egg production was not so high with the hens as with the pullets, the general differences between the various supplements were similar. The number of pullets raised to laying age from each pen gave an accurate reproductive index indicating the effects of the various supplements on reproduction as well as egg laying. The daughters from the ten pens in the experiment are being tested, under uniform conditions, for production, reproductive qualities and mortality, to determine if there is any "carry-over" to the offspring, of the effects of feeding vitamin D supplements to breeding stock.

Longevity in Poultry. The relationship between age, egg production and hatchability is being studied tho, of necessity, the accumulation of data is slow, especially data from hatching any considerable number of eggs from hens five years of age and older.

Effect of Cod Liver Oil on the Iron and Copper Content of Egg Yolk. Eggs are high in food value because they contain a number of constituents important for the nutrition of the human body. One of these is iron, long known to be necessary for the formation of hemoglobin. Another is copper, the necessity of which for hemoglobin production has been established comparatively recently.

It has been found that cod liver oil, when fed to laying hens, increases both the iron and copper content of the eggs and also the egg production. Sunshine and bluegrass have a like effect on the copper content of eggs whether cod liver oil is fed to the hens or not, and a like effect on the iron content, when cod liver oil is not fed. When cod liver oil is fed, the effect of sunshine and bluegrass is to cause a slight decrease in the iron content of the egg yolk. Because of these variations found in egg production and in egg yolk constituents, hemoglobin determinations were made on hens kept under experimental conditions for one year. After that time, the hens were

killed and the blood and blood-free liver, spleen and kidney tissues were dried, ashed and the iron and copper determined in the ash. In the confined pens, the average hemoglobin was lower in the hens that were not fed cod liver oil. It seemed to make little difference whether they did or did not get sunshine while they were confined. Of the hens allowed open bluegrass range, the hemoglobin content was higher in those fed cod liver oil than in those that did not get it. Another lot of older hens gave practically the same results, except that at the end of the twelve-month experimental period, the hens allowed bluegrass range and cod liver oil, showed lower hemoglobin in the blood than the ones allowed bluegrass range but no cod liver oil. The hemoglobin of these birds was determined four months after the experimental ration had been started. At that time, in both the confined pens and those on bluegrass range, the hemoglobin values were higher in the hens getting cod liver oil than in the ones without it. It was also interesting to note that the highest hemoglobin values were found in the confined hens. The egg production of these was lowest and the copper and iron content of the eggs lowest. At the end of the experimental period, the hemoglobin of all the hens was lower than it was after four months on the experimental ration. These data seem to indicate that when production is high and the iron and copper content of the eggs produced is high, the hemoglobin of the hens tends to decrease.

To determine whether the metabolism of copper and iron in the hen is affected by cod liver oil and, if so, in what way, analyses were made of the blood and the blood-free kidneys, livers and spleens of the hens on the experimental ration. The results of the analyses show that the iron content of the liver, spleen and kidney is greater in the hens confined without cod liver oil than in those given cod liver oil. The hens allowed open bluegrass range, however, had practically the same iron content in the spleen and kidney, whether they were fed cod liver oil or not, but the liver showed an increased iron content in those fed cod liver oil. The copper content of the spleen and kidney increased in the confined hens given cod liver oil. In

the liver, the copper decreased in the hens confined without sunshine, but fed cod liver oil. The copper of the liver in hens confined with sunshine and in the hens allowed open bluegrass range was practically the same, whether they were fed cod liver oil or not. When the hens were allowed open bluegrass range, the copper content decreased in the spleen of those fed cod liver oil, but increased in the kidney.

Agglutination Test for Pullorum Disease. Tests have been conducted yearly for eight years, on a flock of approximately 1,500 birds. On the first test, 15 per cent of the birds were found to be reactors. Before the test was begun, some chicks were affected with pullorum disease each year. Since yearly testing was started, more than 30,000 chicks have been hatched from this flock. No loss of chicks from pullorum disease has occurred. The number of reactors has gradually declined and in the last two tests, only one percent of the flock reacted. These facts demonstrate conclusively that loss of baby chicks can be controlled by the application of the agglutination test. They further suggest that frequent testing is necessary to eradicate the disease from a flock.

Infectious Abortion. Vaccine was prepared from *B. abortivo-equinus* and administered to 1370 mares on 47 farms. Fifty-three samples of equine blood were tested for abortion. Seventeen fetuses were cultured, a streptococcus was isolated from one, the other sixteen were negative to the *B. abortivo-equinus*. Vaccine was prepared for 217 cattle in 12 herds, and one swine fetus was cultured and vaccine prepared from *Br. abortus suis*, for 12 sows.

A study was made of the serological tests of fifty-two strains of the *B. abortivo-equinus*. Some of these strains were isolated as early as 1911 and some as late as 1933. These studies comprise the comparative agglutination, cross agglutination, agglutinin-absorption and precipitin tests of these strains. Also these strains were compared by the same tests with a limited number of other closely related organisms of the Salmonella group. So far as the work has progressed, it was found that fifty strains of *B. abortivo-equinus* were of one type, and identity

distinct from other members of the *Salmonella* group. The type of two strains of *B. abortivo-equinus* has not as yet been determined.

Feed Control. Consumption of commercial feeds has increased 16 percent, in 1933, over 1932. This is still approximately 50 percent below consumption in the decade, 1921-30. There has been only a slight increase in the price level of 1933 over 1932, but the increase in volume would indicate that the price level is gradually increasing also.

For the year, 1933, 992 samples were analyzed, both chemically and microscopically, and the results reported to those directly concerned. In the main, the results show that feeds sold in Kentucky during this period were well up to their guaranties and of a high standard in quality. In fact, many of the mixed and special-purpose feeds exceeded their guaranties as high-protein carrying materials were so plentiful and cheap that manufacturers used them liberally in their mixtures. Filler materials were so cheap that they were not worth their freight and their use was comparatively small.

One state case was filed during the year and three filed in 1932 were closed during the year in favor of the Department. No Federal cases were filed during the year but three filed in 1932 were closed in favor of the Department.

Bulletin 340, Commercial Feeds in Kentucky in 1932, was published.

Fertilizer Control. Analyses were made of 660 samples of fertilizer submitted by farmers and inspectors. The registration included 710 different brands of fertilizer for which 1,402,000 tags were issued.

Seed Analysis. The total number of samples of seed analyzed was 3,848. Tests for purity numbered 2,436; for germination 2,690. The samples were distributed as follows:

Grasses, 624		Vegetables, 44	
Bluegrass	284	Large Seed, 288	
Redtop	66	Corn	70
Orchard Grass	187	Soybeans	87
Timothy	60	Cowpeas	28
Sudan Grass	5	Wheat	20
Millet	14	Barley	7
Canes	7	Rye	24
Rye Grass	1	Oats	43
Clovers, 1,991		Hemp	9
Red Clover	283	Tobacco	
Sweet Clover	36	No. of samples tested....	901
White Clover	1	No. of pounds cleaned....	979
Crimson Clover	7		
Alsike Clover	50		
Lespedeza	1,587		
Alfalfa	27		

There were six prosecutions under the seed law, five of which resulted in fines against those charged with violation of the provisions of the law. In the sixth prosecution the jurymen were unable to agree upon a verdict and the case was recorded as a "hung jury". Two additional cases are now pending.

Nursery Inspection. Since the state appropriation was discontinued the activities in the field of nursery inspection have been curtailed. Nurseries were inspected where it was possible to carry the work in connection with other lines of endeavor. Five of the six cases of violation of the provisions of the Nursery Inspection Act were successfully prosecuted. During the year 301 licenses were issued. These were grouped as follows:

Nursery agents	23
Resident nurseries	88
Non-Resident nurseries	93
Dealers	97

Creamery License. Licenses to buy milk and cream on the butterfat test were issued to 11 creameries, 5 cheese factories, 6 condenseries, 46 milk plants and ice cream manufacturers, 56 independent operators of cream stations, and 994 cream stations operated by creameries. These total 1,118, of which 998 were

renewal licenses and 120 for new buying places beginning operation since June 30, 1933.

Permits in lieu of license to test, pending examination, were issued to 65 operators of the Babcock Test and are now in force; 120 applicants have been examined and licensed since June 30, 1933, and 895 operators have been issued renewal licenses. Examinations for applicants for license to test were held as follows: Bowling Green 4, Cincinnati 2, Columbia 1, Lexington 3, Louisville 3, Mayfield 1, Maysville 1, Owensboro 2, Paducah 3, specials 11, a total of 31. At these examinations 460 operators were notified to appear, 287 appeared and 274 or 95 percent made passing grades.

A total of 823 inspections, including 11,223 individual tests, were made. Of these 647 were graded A, B, or C (excellent to mediocre), 159 were of D grade, placing them on probation, and 17 were of E grade, causing these testers to be called before the Examining Board. The following testing equipment was condemned during the year: 6 test scales, 26 9-gram weights, 2 milk pipettes, 21 test bottles, 6 pair dividers, 7 thermometers and 5 centrifuges.

The Examining Board considered 17 cases of inaccurate testing and failure to comply with regulations. On the recommendation of the Board the licenses of 11 testers were revoked, 1 license was temporarily revoked, 3 testers and 1 buyer were placed on strict probation with provision that their licenses will be revoked if subsequent inspections are not satisfactory. One decision was withheld (because of tester's claim of continued theft of cream). Two buying places were ordered closed for violation of regulations.

Investigations were made to determine the effect of keeping cream samples. Samples kept 2 to 4 days, in 2-oz. jars with tight-fitting tops lined with rubber increased in test from 0 to 1 percent, the average being 0.2, in 160 comparisons. This varied from .01 in winter to 0.4 in summer. Samples stored in an ice box (temperature 30-31°) showed no change. Nine-gram charges weighed into test bottles, preservatives added and kept

1 week showed the following changes as compared with check tests (average of 3 trials, 20 samples each), viz.:

Preserved with bichloride of mercury	+ .1%
Preserved with formaldehyde	— .4
Preserved with $\frac{3}{4}$ drops sulfuric acid	+ .2

Glassware received from manufacturers, totaling 18,040 pieces, was inspected and stamped. One hundred and six pieces were rejected because not Kentucky Standard or because inaccurate.

The receipts for the year were \$6,880.50 and the expenditures \$9,715.58, as itemized:

Salaries	\$7,662.00
Labor	143.90
Postage and stationery	299.58
Freight and express	6.86
Sundry and laboratory supplies.....	36.47
Travel	1,547.27
Contingent	19.50
 Total	 \$9,715.58

Personnel. The staff of the Experiment Station is shown on page 3 of this report. No new appointments were made to the staff during the year. There was one resignation, that of Mr. Wesley Brooks, field agent in cream grading, effective February 15.

New Projects:

Farm taxes and county government in Kentucky.

The fixation and accumulation of nitrogen in soil on which bluegrass is grown in association with certain legumes.

A chemical investigation to ascertain if commercial products can be obtained from unmarketable tobacco.

The effect of cropping and soil management practices on the yield and quality of the cured leaf of white burley tobacco.

A study of land utilization in selected regions in Kentucky with particular reference to classifying the land on the basis of

its net productivity and its potentialities when devoted to crop production, pasturage, forestry and other possible uses.

Marketing milk in Kentucky.

The growth and yield of lettuce, potatoes, lima beans and cucumbers with different contents and ratios of nitrogen, phosphorus and potassium in the conducting tissues induced by application of material containing these elements.

The reliability and practicability of rapid field tests on certain conducting tissues of plants as guides for soil treatment.

A study of the effects of solar radiation and radiations having rays of different wave lengths on the development of sex characters in White Leghorn chickens and the influence of the removal of comb, wattle or testes on the sex characters.

Kentucky marls as sources of calcium for laying hens.

A study of alfalfa failure.

Studies in the improvement of the quality of sorghum sirup.

Investigations in soil heating by using electricity.

Heating laying houses.

Early-cut soybean hay vs. late cut-soybean hay in the wintering of grade beef calves.

Sirup sorghum grain for laying hens.

Activators for nicotine sulfate in control of leafhoppers.

A study of white grubs and their damage to farm crops.

A study of new spray mixtures.

Publications:

Bulletins:

- No. 337. Cod liver oil for laying pullets. J. Holmes Martin and W. M. Insko, Jr. February, 1933.
- No. 338. Hemolytic streptococci of horses and other animals, and their relation to the streptococci of man. W. W. Dimock and P. R. Edwards. May, 1933.
- No. 339. Black-stem of alfalfa, red clover and sweet clover. E. M. Johnson and W. D. Valleau. May, 1933.
- No. 340. Commercial feeds in Kentucky in 1932. J. D. Turner, H. D. Spears, W. G. Terrell and L. V. Amburgey. May, 1933.

- No. 341. Resistance of red clovers to *Sclerotinia trifoliorum* Erik., and infection studies. W. D. Valleau, E. N. Ferguson and Lawrence Henson. June, 1933.
- No. 342. The iron and copper content of egg yolk. S. E. Erikson, R. E. Boyden, J. Holmes Martin and W. M. Insko, Jr. June, 1933.
- No. 343. The use of credit on selected Kentucky farms. C. J. Bradley. June, 1933.
- No. 344. Marketing Kentucky livestock by motor truck. C. D. Phillips. July, 1933.
- No. 345. The use and expense of farm implements. Geo. B. Eyers and B. T. Inman. December, 1933.

Scientific Papers:

- A ringspot-like virus disease of red clover. E. M. Johnson. *Phytopathology* 23 : 746-747, 1933.
- Symptoms of phosphorus deficiency in Turkish Tobacco P. E. Karaker and C. E. Bortner, *Jour. Amer. Soc. Agronomy*, Vol. 25, No. 8, pp. 558-559. 1933.
- How Kentucky adopted a standard milk-house plan. J. B. Kelley, *Agr. Eng. Jour.*, March, 1933, p. 76.
- The composition of the blood of starved ewes. G. Davis Buckner, Wayland Rhoads and E. J. Wilford. Read before the 20th annual meeting of the Kentucky Academy of Science, April 29, 1933. *Transactions*, Vol. 6 (in preparation).
- Abnormal growth of wattles and testes of cockerels after removal of combs. G. Davis Buckner, W. M. Insko, Jr., and J. Holmes Martin. *Amer. Jour. Physiol.*, Vol. 103, No. 3, pp. 647-650, March, 1933.
- The iron and copper content of egg yolk, S. E. Erikson, R. E. Boyden, J. Holmes Martin and W. M. Insko, Jr., *Proc. Amer. Soc. Biol. Chem.*, Vol. 27, pp. XL-XLI, April, 10-12, 1933.
- Relationship between age, fecundity and hatchability. J. Holmes Martin and W. M. Insko, Jr. Presented at the 25th An. Meet. Poul. Sci. Assn., August, 1933; abstract, *Poul. Sci.*, Vol. 12, No. 5, pp. 319-320.
- The influence of battery brooding on subsequent egg production. G. Davis Buckner, J. Holmes Martin and W. M. Insko, Jr. Presented at the 25th An. Meet. Poul. Sci. Assn., August, 1933; abstract *Poul. Sci.*, Vol. 12, No. 5, pp. 334.

- Effect of frequent turning on hatchability and distribution of embryo mortality. W. M. Insko, Jr., and J. Holmes Martin. Poul. Sci., Vol. 12, No. 5, pp. 282-286, September, 1933.
- Some factors affecting gonad, comb and wattle development of the chicken. G. Davis Buckner, J. Holmes Martin and W. M. Insko, Jr., Proc. 5th World Poul. Cong., Rome, 2nd Sec., Paper No. 27, September, 1933.
- Calcium and phosphorus in the development of the turkey embryo. W. M. Insko, Jr., and Malcolm Lyons, Jour. Nutr., Vol. 6, No. 6, pp. 507-513, November, 1933.
- Sex characters of colony and battery-brooder raised White Leghorn chickens. G. Davis Buckner, W. M. Insko, Jr., and J. Holmes Martin, Poul. Sci., Vol. 12, No. 6, 392-396, November, 1933.
- A year's measurement of improvement in butter quality from the four-day plan of buying cream. H. B. Morrison. Presented at the 1933 Summer Meeting of the American Dairy Science Association. Abstract p. 48 of abstracts of papers published by the American Dairy Science Association.
- Building butter quality. H. B. Morrison, J. O. Barkman, and J. A. Britt, City Consumers Company, Paducah. American Creamery and Poultry Produce Review, Vol. 76, No. 11, p. 348.
- Parasites of horses: prevention and treatment. W. W. Dimock. The Iowa Veterinarian, Vol. 4, No. 7, pp. 5 and 18, 1933.
- Further studies on the differentiation of human and animal strains of hemolytic streptococci. P. R. Edwards, Jour. Bacteriology, Vol. 25, pp. 527-36. 1933.
- Diversity of types found in stock cultures of *Streptococcus epidemicus*. P. R. Edwards. Amer. Jour. of Hygiene, Vol. 18, pp. 345-53, 1933.
- Salmonella ærotrycke* in colitis of foals. P. R. Edwards. Jour. Infec. Diseases, Vol. 54, pp. 85, 1933.
- A note on some recent work in experimental bovine mastitis. P. R. Edwards. Cornell Veterinarian, Vol. 23, pp. 177-84. 1933.
- New ideas in dairy nutrition. Daniel J. Healy. The Jersey Bulletin, 52, 5, p. 151, 1933.
- New idea in dairy nutrition. Daniel J. Healy. Live Stock Bulletin, Brisbane, Australia, April, p. 4, 1933.
- New ideas in animal nutrition. Daniel J. Healy. Ky. State Vet. Med. Assoc., July, 1933.

The chemical characters of the blood and urine of colts. W. W. Dimock and D. J. Healy, Jour. Amer. Vet. Med. Assoc., N. S., 36, 6, p. 806, 1933.

Further evidence that boron is essential for the growth of lettuce. J. S. McHargue and R. K. Calfee. Plant Physiology, Vol. 8, pp. 305-313. 1933.

Iodine in the water supply of Lexington, Kentucky. J. S. McHargue and D. W. Young. Jour. Amer. Water Works Assoc., Vol. 25, No. 3, pp. 380-382. March, 1933.

Report on less common elements in soils. J. S. McHargue. Jour. Asso. Off. Agr. Chemists. Vol. 16, No. 2, pp. 207-12, May, 1933.

Report on less common elements in plants. The determination of boron spectroscopically. J. S. McHargue. Jour. Asso. Off. Agr. Chemists, Vol. 16, No. 4, pp. 465-71. Nov. 15, 1933.

The iodine content of the soil of Kentucky. J. S. McHargue and D. W. Young. Soil Science, Vol. 35, No. 6, pp. 425-435, June, 1933.

Application of the ferric thiocyanate method for the determination of fluorine in normal plant and animal tissues. J. S. McHargue and R. K. Calfee. Presented before the Division of Agricultural and Food Chemistry of the American Chemical Society at the Chicago meeting in September, 1933, and accepted for publication in Ind. and Eng. Chem.

The mineral content of milk from a Jersey and a Holstein cow during the period of lactation. J. S. McHargue, F. Ely, W. R. Roy and D. W. Young. Presented before the Division of Biological Chemistry of the American Chemical Society at Chicago meeting in September, 1933. This paper will be submitted for final publication in the near future.

A combustion method for the determination of iodine in plant material. J. S. McHargue and D. W. Young. Presented before the Division of Agricultural and Food Chemistry of the American Chemical Society at the Chicago meeting in September, 1933. Additional data are being obtained before this paper is submitted for final publication.

The resistance of leaves of red clover to puncturing. H. H. Jewett. Jour. Econ. Entomology. Vol. 26, No. 6, pp. 1135-37. December, 1933.

Fermenting cornstalks as a substitute for manure in hotbeds. E. M. Emmert. Proc. of the A. S. H. S. for 1932, pp. 493-495.

The effect of soil moisture on the availability of nitrate, phosphate and potassium to the tomato plant. E. M. Emmert and F. K. Ball. Soil Science, Vol. 35: No. 4, pp. 295-306. April, 1933.

Indirect colorimetric method for the determination of calcium. Plant Physiology 8: 469-473, 1933.

Rapid colorimetric determination of total carbon and nitrogen in the same sample. E. M. Emmert. Jour. Asso. Off. Agr., Chemists, Vol. 16, No. 3, pp. 424-27. Aug. 15, 1933.

ROBINSON SUBSTATION

Improvement of Sorghum for Sirup. Fertilizing sorghum with 200 pounds of nitrate of soda per acre, applied in the row, increased the yield of sirup about 30 percent. This was hardly sufficient, however, to pay for the fertilizer. Six tons of manure were slightly more effective in increasing the yield of sirup than the nitrate of soda. At the time of harvesting the twelve varieties of sorghum tested, only the Atlas variety had not blown down. However, four other varieties produced more sirup per acre than did the Atlas.

Crops. Good yields were obtained from corn and alfalfa. On 11 acres of bottom land, 865 bushels of corn were produced. The varieties used and the yields for each are as follows: Tennessee Red Cob, 95 bushels per acre; Johnson County White, 90 bushels per acre; Reid's Yellow Dent, 60 bushels per acre. The planting of yellow corn will be discontinued, as it has been proved that it does not yield as well as white corn. Three cuttings from six acres of alfalfa yielded from 27 to 30 tons of hay. The peach crop was a total failure on account of late freezes. The apple crop was light, but the apples that matured were of good quality and sold at a good price. Small fruits and grapes made good yields.

Meetings. Five meetings were held this year: a camp for farm women; a leaders' conference; a camp for 4-H boys and girls; the eighth annual Robinson Harvest Festival, and a regional conference of mountain workers. The attendance at the meetings was larger than in previous years.

Forestry. A large amount of work was done on the forest this year because of the location thereon of an Emergency Conservation Work camp. Robinson Forest was designated as ECW Camp S 51, to which members of CCC Company 547 were assigned. The main accomplishment was the construction of an 18-foot roadway, connecting the camp and Kentucky state highway No. 15. This is essential to the present heavy traffic load to and from camp, as well as to the future development of the transportation of forest products, fire fighters and forest users. The maintenance of a level grade on this road and the elimination of fords involved the construction of five vehicle bridges. They were built entirely of native materials. By far the largest item in the contemplated program is that of forest stand improvement. This covers the improvement of stands thru the removal of blight-killed chestnuts, etc. The present program will accomplish in two or three years, work which ordinarily would require at least 50 years, or which might never be accomplished during the first timber rotation.

The coniferous plantings at the Robinson Forest are perhaps the most extensive in the state. There are now 40 planting plots and an aboretum on the forest. In the experiments on the plots are five species of exotic trees, five species not indigenous to Kentucky, and eight species indigenous to this region. The best results were obtained with the indigenous species.

WESTERN KENTUCKY SUBSTATION

Pasture Production. The only outstanding difference in the results from the pasture experiments, in comparison with previous years, was the marked superiority of the field fertilized with rock phosphate, as measured in pounds of beef from 164 days of grazing. It produced 160.5 pounds per acre, in contrast with the field fertilized with limestone and superphosphate, which produced 134.0 pounds of beef. The unfertilized field produced 50.5 pounds per acre. The vegetation on the rock phosphate treated field consisted mainly of redtop and annual lespedezas; that on the limestone-superphosphate treated field

consisted of orchard grass, Kentucky and Canadian bluegrass, and annual lespedezas. Orchard grass was dominant and the lespedezas less abundant than on the rock phosphate treated land.

Orchard Tests. Apple trees on plots receiving cultivation followed by a winter cover of rye and vetch continued to make the best growth. A small crop of apples was produced. No benefit can be observed from the use of phosphorus or potassium as fertilizers for peach trees so far as the trees are concerned, but the growth of cover crop was improved where phosphorus was used. All plots receiving cultivation and cover crops made better growth than plots sown down to sweet clover or lespedeza. There was no peach crop this year.

Strawberries. The strawberry crop was severely damaged last spring by a hailstorm and the damage from the hail was not uniform over the different plots. This makes the interpretation of results for this year very difficult. In general, it appeared that the check plots receiving no fertilizer treatment made the best yields. This is in line with results from previous years.

Raspberries. As a large number of canes died from an undetermined cause, spraying tests were made. Bordeaux mixture was found to have a striking beneficial effect on the growth of the canes this season and on the retention of foliage thru the latter part of the summer. No injury from the use of Bordeaux mixture was observed. In a recent check up it was found that the unsprayed rows were showing a large number of dying canes.

Fineness of Ground Limestone and Rates of Application. In the fall of 1926, 2 tons of ground limestone, per acre, were applied to certain plots, 1 ton to others, and limestone of different degrees of fineness to others at the rate of $\frac{1}{3}$ ton per acre. The 2- and 1-ton applications have not been repeated, but the $\frac{1}{3}$ -ton applications were repeated in 1931 when wheat was sown. All the limed plots were treated with superphosphate and potash. A legume mixture consisting of red clover, alsike

clover, alfalfa and Korean lespedeza was seeded on the wheat. The clovers and alfalfa were a failure on all plots except those on which $\frac{1}{3}$ -ton of limestone was applied. On these the yield of clover and alfalfa ranged from 1,940 to 2,640 pounds per acre, with an average of 2,235 pounds. A cutting of lespedeza was made in the fall. The lespedeza was quite clean on the limed plots from which no clover was harvested (2-ton and 1-ton rate). On those plots from which clover was harvested ($\frac{1}{3}$ -ton applications) the larger the clover yield the thinner the stand of lespedeza and the more weeds the hay contained. Reduced to a weed-free basis, the yields of lespedeza were as follows: The check plots produced an average of 1,375 pounds of hay per acre. An average of 1,110 pounds of hay per acre was produced on the plots to which $\frac{1}{3}$ -ton of limestone was applied. The yields of lespedeza from the plots to which 2 tons and 1 ton of limestone were applied in 1926 were 2,915 pounds and 2,365 pounds, respectively. The total average of both cuttings of hay for the $\frac{1}{3}$ -ton application was 3,345 pounds per acre. The average yield of lespedeza for the 2-ton and 1-ton applications (where clover failed) was 2,640 pounds. Hydrated lime showed about the same effect in equivalent small applications as did the limestone. A plot on which 250 pounds of fine limestone were applied at the same time as the $\frac{1}{3}$ -ton application was made produced 1,240 pounds of clover and 2,090 pounds of lespedeza. No clover and only 1,055 pounds of lespedeza were produced on the check plot lying next to it.

Meetings. Important meetings held at the substation this year were: Conference of Orchardists of Western Kentucky; Second Annual Short Course; 4-H Club Leaders Conference; Annual Field Day Meeting; and Special Tobacco Conference. These meetings were well attended, especially the annual field day meeting, which attracted between 600 and 700 visitors.

FINANCIAL STATEMENT

In Account with the United States Appropriations, 1932-33.

	Hatch Fund	Adams Fund	Purnell Fund
Receipts:			
From the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1933, under acts of Congress approved March 2, 1887 (Hatch Fund), March 16, 1906 (Adams Fund), and February 24, 1925 (Purnell Fund).....	\$15,000.00	\$15,000.00	\$60,000.00
Expenditures:			
By personal services	14,619.25	14,801.82	56,580.51
Supplies and materials		44.35	1,008.90
Communication service			72.00
Travel expenses	53.91		1,113.16
Transportation of things		.49	20.35
Publications	326.84		985.49
Heat, light, water, and power		22.90	69.09
Equipment		130.44	150.50
Total	\$15,000.00	\$15,000.00	\$60,000.00

Interest earned on above during the period indicated, aggregating \$125.18, was deposited in the United States Treasury by check No. N 7149, dated June 30, 1933, drawn by D. H. Peak, Business Agent, to the order of the Treasurer of the United States.

We, the undersigned, duly appointed auditors of the expenditures from Federal appropriations reported herein, do hereby certify that we have examined the books and accounts of the Kentucky Agricultural Experiment Station for the fiscal year ended June 30, 1933; that we have found the same well kept and classified as above; and that the balances, receipts and disbursements are as follows:

	Hatch Fund, of Act of Con- gress Mar. 2, 1887	Adams Fund, Act of Con- gress Mar. 16, 1906	Purnell Fund, Act of Con- gress Feb. 24, 1925	Totals, All Funds
Receipts for the year from the Treasurer of the United States	\$15,000.00	\$15,000.00	\$60,000.00	\$90,000.00
Disbursements for the year	\$15,000.00	\$15,000.00	\$60,000.00	\$90,000.00
Unexpended balance June 30, 1933	None	None	None	None

Proper vouchers for all of the above disbursements are on file and have been examined by us and found correct.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, March 16, 1906, and February 24, 1925, and in accordance with the terms of said acts, respectively.

Signed:

THOMAS COOPER,
Director of the Experiment Station
D. H. PEAK,
Financial Officer of the Institution
D. H. PEAK,
Secretary of the Governing Board

Auditors

[SEAL]

Attest:

JANE J. NICHOLS,
Custodian of the Seal.

